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THE HEIGHT OF BUILDINGS IN WASHINGTON is restricted to 90 ft. on residence streets and 110 ft. in business sections by the bill before Congress. The bill further provides that combustible or non-fireproof buildings for residences, apartments or hotels shall not exceed five stories or 60 ft. in height. Non-fireproof business buildings are limited to 75 ft. in height. The bill provides further that all buildings, except churches, hereafter erected or altered to exceed 75 ft. in height, shall be fireproof or non-combustible. Churches must be of fireproof construction up to and including the main or auditorium floor. No building shall be erected or altered to exceed in height above the sidewalk the width of the street in its front, and in no case shall a building exceed 90 ft. in height on a residence street nor 110 ft. on a business street, except on business streets and business avenues 160 ft. wide, where a height not exceeding 130 ft. may be allowed. The height of buildings on corner lots shall in all cases be regulated by the limitations governing on the broader street, provided that spires, towers and domes may be erected to a greater height than the limit herein prescribed, when approved by the Commissioners of the District of Columbia.

THE BUILDING CODE COMMISSION recently appointed by the Mayor of New York city met in the council chambers of the city hall on Jan. 30 to organize. Building Commissioner Brady, of Manhattan, was elected chairman; Commissioner Rudolph L. Daus, of Brooklyn, secretary, and George H. Nicholas, assistant secretary. The commission will hold daily meetings at the Department of Buildings until permanent quarters are secured.

THE NEW CHARTER FOR SAN FRANCISCO, reviewed editorially in our issue of May 26, 1898, has been ratified by the practically unanimous vote of the State Legislature.

NEW STREET CLEANING SPECIFICATIONS FOR San Francisco provide that no dust shall be raised by sweeping; that in the hand labor district the contractor shall keep sprinkling carts in constant operation; and that he shall be fined 50 cts. for every block upon which dust is raised by the men in sweeping. White uniforms for the sweepers are to be introduced. The specifications were prepared by the Merchants' Association.

AN ACCIDENT resulting in the death of two workmen, and the injury of 16, occurred near Altoona, Pa., on Jan. 29, at the western opening of the Gallatzin tunnel. The men heard the approach of a locomotive, running west through the tunnel, presumably on the west-bound track, and crossed over to the east-bound track. The smoke in the tunnel prevented them seeing the locomotive, which was running on the east-bound track, owing to obstructions on the usual west-bound track, and they were run down.

THE AUTOMATIC SPRINKLER SYSTEM commonly used in cotton and woolen mills and warehouses depends for its working upon the pumps, valves, etc., of the pipe line always being in proper order. The report of the Boston Manufacturers' Mutual Insurance Co. for the month of December contains a "warning and caution," stating that during the month two sprinkler valves—one a 6-in. controlling the service of an entire mill and one a 5-in. controlling the service of half a large mill—were found "strapped and riveted, closed," while they had been examined every week for several months and their condition reported and reports kept on file, stating that they were "strapped and riveted, open." The remedy recommended for the great danger of having valves shut that ought to be open in a sprinkler line is to have indicators fitted to all such valves, so as to show whether they are shut or open.

CENTRAL ELECTRIC LIGHTING STATIONS in the United States are tabulated in the "American Electrical Directory and Buyers' Manual" for September, 1898. The following totals are given by way of comparison:

	No. stations.	Total arc lights.	Incandescent lamps. Direct-current.	Incandescent lamps. Alternate-current.	Incandescent lamps. Total	Engine, horse-power.
Municpl	334	26,185	61,695	317,970	379,665	69,145
Private[1]	2275	265,708	2,312,221	4,988,231	7,300,452	994,688
Total	2,609	291,893	2,373,916	5,306,201	7,680,117	1,063,833

[1]Capital stock, $246,319,610.

STEAM POWER IS GOING OUT OF USE in small plants in Philadelphia, Pa., owing to the substitution of electric power generated in large central stations. According to the annual report of Mr. John Overn, Chief of the Bureau of Engines and Boilers, in Philadelphia, 625 boilers are located in place but are "temporarily out of use" out of a total of 3,579 boilers under the supervision of the bureau; the larger number out of use being due chiefly to the substitution of electric power. During the year 1898, 306 new boilers of different styles were erected in the city as follows: Horizontal tubular, 112; compound tubular, 9; vertical tubular, 115; locomotive, 9; sectional, 46; patent boilers, 17. No explosion of a steam boiler occurred in the city during the year, but two serious accidents occurred to steam piping used in connection with engines and boilers, each involving loss of life.

THE NATURAL GAS SUPPLY OF INDIANA has diminished to such a point that its early exhaustion is imminent, unless steps are taken to reduce the draft upon the wells. The question is again coming up, therefore, as to whether the piping of gas outside the State cannot be stopped. When the pipe line to Chicago was first projected, in 1889, the Legislature passed a law prohibiting it, but the courts decided that the law was unconstitutional, it being in restriction of Interstate Commerce. Besides the Chicago pipe line, lines have been built which supply gas to 14 cities and 18 towns and villages in Ohio, including the once famous natural gas town of Findlay. A conference of men interested in the future of the gas fields was held at Muncie on Jan. 19 to consider some action against the pipe lines. It was decided to ask the courts to enforce a law, passed by the legislature in 1891, forbidding the carrying of over 300 lbs. per sq. in. pressure at any point in a gas pipe line. It is said that the Ohio Pipe Line Co. carries a pressure of 750 to 1,000 lbs. and the Chicago line 600 lbs. at the pumps.

THE MOVING OF A DRAWBRIDGE carrying the Chicago & Northwestern Ry. over the Kinnickinnic River at Milwaukee, Wis., was successfully effected on Dec. 18. The bridge was built in 1890, and is 175 ft. long, weighing about 255,800 lbs. It was moved 200 ft. down the river, where it will be used during the erection of a new structure on the original site. Two scows, ballasted with water and fitted with blocking, were placed under the bridge, one on each side of the center pier, and the water was pumped out until they carried the weight of the structure. They were then floated down stream and the bridge was deposited on its new pier by again letting water into the scows. The work occupied 2 hours and 50 minutes, from the time the last train crossed to the time when the bridge was swung by its own machinery on its new pier. The method of handling was similar to that employed for removing an old bridge and placing a new bridge over the Chicago River at Kinzie St., for the same railway, as noted in our columns some time ago. Both these pieces of work were done under the supervision of Mr. W. H. Finley, Bridge Engineer of the Chicago & Northwestern Ry.

THE DETROIT RIVER BRIDGE project is thus outlined by a correspondent familiar with its present status:

Regarding the bridge over the Detroit River, it may be stated that the matter is merely in its preliminary stages, only the location and general plan having yet been decided upon, subject, of course, to approval by the U. S. government. The conditions made it desirable to draw up a typical plan for a crossing of the river at some definite point, which had been decided upon as the most desirable for various reasons, and this location is between the buoy at the lower end of the Middle Ground Shoal and the south end of Belle Isle. The proposed structure will be a high bridge, 117 ft. above the water, with a clear cantilever span of 1,300 ft. over the Canadian channel, and a total length of cantilever construction of about 2,400 ft. There is also a steel viaduct about 1,000 ft. in length and three truss spans over the American channel about 335 ft. long, each. In connection with the construction, provision has been made for a new highway bridge to Belle Isle Park, located under the three railway spans crossing the American channel at an elevation about 20 ft. above the water, consisting of two truss spans of about 335 ft. each and a draw span between them of about the same length. In addition to the above there will be required the necessary approaches to the bridge on each side of the river. As already stated, this project is still undetermined, as the matter has to go before Congress and the U. S. engineers have to approve of the proposed location before any definite action can be taken regarding the construction. As the site selected will permit the construction of a bridge without placing any piers in the navigable channel of the river it is believed that the bridge is less likely to be opposed by the vessel interests than if constructed lower down the river. They have always opposed a bridge elsewhere because of the piers which it was necessary to put in the navigable waters on account of the greater width of the channel. Mr. Chas. C. Bothfield is the consulting engineer for the proposed bridge.

THE OHIO CENTENNIAL, which is planned to be held at Toledo, O., in 1902, is making satisfactory progress. At the last session of the Ohio Legislature a special commission was appointed to consider the matter of the proper celebration of the 100th anniversary of the admission of Ohio into the Union. They reported and made the recommendation that an exposition of arts and trades be held at some city to be selected by the commission. Toledo, Columbus and Cleveland were candidates, and on the first ballot it was decided by a large majority to hold the exposition at Toledo, on account of its being easy of access, and located on the lake and with a lake front site for the fair, and also on account of the fact that Perry's victory on Lake Erie and many of the land battles of the Indian wars and of the war of 1812 were fought within a few miles of there. Ft. Meigs and Ft. Miama are only six miles from the city. The plan has progressed to date this far: A Centennial Commission of nine was named to prepare plans and to construct all but the buildings. All of the work on the grounds is under this commission directly. A company has been organized which will construct the buildings and operate the fair, advancing all money for temporary improvements. This company will work on general lines to be approved by the commission. In addition, a State Commission or Board is appointed to secure outside State support. All these bodies are said to be working hard and in harmony. The commission in December named Mr. W. J. Sherman, of Riggs & Sherman, civil engineers, Toledo, O., as Chief Engineer, and preliminary surveys and topographical and hydrographic maps have been completed. Many suggestions as to plans have come in, and the three boards have appointed a commission of five experts to prepare a final plan. This commission consists of W. J. Sherman, civil engineer; David L. Stine, architect; M. W. Moore, landscape engineer; T. H. McLean on transportation, and Wm. H. Stewart on space and exhibits. The commission has been at work for some weeks, and has made substantial progress on general plans. It will complete its work by Feb. 15. The commission now has $150,000 immediately available, and the company $50,000 with which to commence the work. The site chosen is Bay View Park, on the shores of Lake Erie just north of the city limits. It contains about 200 acres of land and has a fine water frontage. A large amount of filling and dredging is necessary and the preparation of the grounds involves an expenditure of something like $150,000 before any building work can be done.

A NATIONAL GUARD ENGINEER CORPS is being organized by Major J. W. Turnbridge, to be known as the First Engineer Corps of the Second Brigade, New York National Guard. The object of the organization is to instruct its members in the theory and practice of military engineering, with instructions by field work and text books, with a regular course of lectures. Among the subjects to be taken up are military bridges, health and comfort of the army in the field, street barricades, mines and counter-mines, military ballooning, bridge and railway repairs, explosives, fortifications, road-making, reconnoissance and map-making.

MANIFOLD PRINTING, by means of Roentgen rays, suggested by Prof. Elihu Thomson in 1896, and further elaborated in Europe, is explained by Dr. F. S. Kolle in the "Electrical Engineer." The process proposes to eliminate composition and presswork and to substitute blocks of 100 sheets of sensitized paper capped by the copy-sheet, either written or printed, in opaque ink. It is claimed that 20 seconds' exposure to the X-rays transfers the copy to the sheets, which are then developed and washed. Twenty such blocks can be exposed at one time about a single tube; and Dr. Kolle estimates an output of 6,000 sheets per minute for each tube; or, ten men working eight hours per day can turn out 7,500,000 copies and develop, fix, wash and dry them. Small cost is claimed.

TEN-YARD CLAM-SHELL DREDGE FOR THE BUFFALO, N. Y., BREAKWATER CONSTRUCTION.

The dredge which we illustrate herewith has been working for some months on the extension of the Buffalo breakwater, and has operated very successfully under somewhat disadvantageous conditions. A portion of the new breakwater consists of a timber crib 36 ft. wide and 22 ft. high, resting on a base of rubble stone. The bottom of the lake being of soft clay, incapable of supporting the rubble base, it was found necessary to excavate a trench to solid rock through this soft material, and to fill it with gravel in order to secure a reliable foundation bed. It is in excavating this trench that the services of the dredge have been employed.

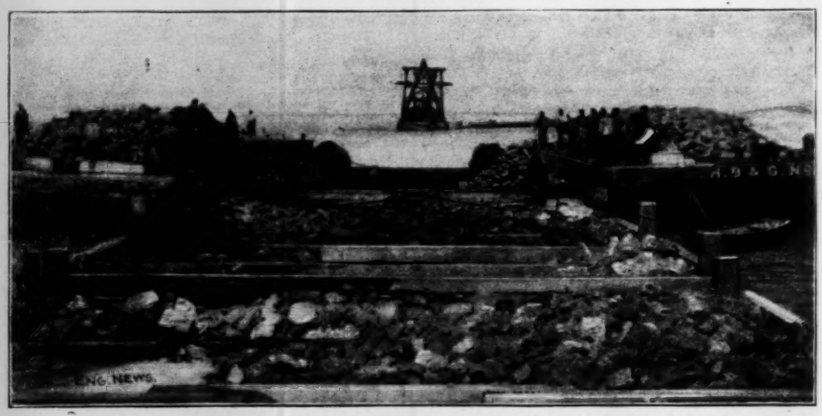


FIG. 1.—VIEW OF BUFFALO BREAKWATER EXTENSION, SHOWING TOPS OF CRIBS AND SCOWS DEPOSITING THE STONE FILLING.
Hughes Bros. & Bangs, Buffalo, N. Y., Contractors.

Along the line of the breakwater the depth of solid rock below the water surface varies from 60 ft. to 80 ft., and the depth of earth overlying it varies from 27 ft. to 49 ft. This overlying material is mostly clay, weighing about 3,300 lbs. per cu. yd., with occasional pockets and strata of a hard-packed fine sand. The trench which the dredge excavates in this material is 120 ft. wide on the bottom, with whatever side slopes the clay naturally assumes. The gravel filling is dumped from scows into the trench as close after the dredge as possible to prevent the sides caving in, and it fills the trench to the level of the original surface only. On the top of this gravel filling comes the rubble base of trapezoidal section and about 8 ft. thick, and then the timber cribs which are filled with broken stone. Fig. 1 gives a very good idea of the crib construction and filling.

The great depth of water, the nature of the material and the large amount of excavation indicated that a large clam shell dredge would be the machine best adapted to do the work. After much discussion it was, therefore, decided to employ a clam shell dredge, and the contract for such a machine was awarded to the Osgood Dredge Co., of Albany, N. Y., by Hughes Bros. & Bangs, the contractors for the breakwater work. The capacity of the bucket was fixed at 10 cu. yds., and the hull and machinery were designed with this capacity as a basis. Figs. 2 and 3 are the sectional elevation and plan of the dredge designed.

As will be seen, the dredge hull, mast, A-frame and boom are wood, about 250,000 ft. B. M., altogether, of timber being employed. The hull is 120 ft. long, 40 ft. beam, and 12 ft. 6 ins. deep. The length given does not include a molded bow and stern of falsework, which were added to make the dredge tow easier, and which increase the total length to 160 ft. The A-frame is 50 ft. high above the deck, and the boom is 65 ft. long. There is a single spud at each end of the hull, but these spuds, instead of extending to the bottom, act simply as attachments for the anchor ropes by which the machine is really held in position. The usual manner of anchoring dredges working in water too deep for spuds is to run the anchor line from the level of the deck. With a beam wind and heavy sea several anchors are usually required to hold the dredge in place, and these interfere seriously with the free handling of scows and tugs alongside. It was, therefore, undertaken to remedy this fault in constructing the present machine.

As already stated, the dredge has at each end amidships a spud 3 ft. square, which extends 25 ft. or 30 ft. below water. At the bottom of each spud are three sheaves, two set across the spud and one fore and aft. On the deck close to the spud are three other sheaves located as shown by Fig. 3. The anchor lines pass from the drums over the sheaves on deck, down along the sides of the spud, through guides cut in the spud wells, and under the sheaves in the bottom of the spud out to the anchors, some 300 ft. away. This arrangement holds the dredge with anchors in six different directions, the lines of which are 25 ft. under water, giving free access to scows and the largest tugs to approach the dredge on all sides. In actual operation, however, the center bow anchor is not used, as it is not required, and its removal leaves no impediment to the free operation of the bucket. The remaining five anchors have proved their ability to hold the dredge on the line of the trench with a strong beam wind and heavy sea. As will be surmised, the dredge moves backward along the line of the cut, the movement being accomplished by hauling in on the center stern anchor line. In conclusion it may be noted that a patent for this form of anchor attachment has been applied for by the Osgood Dredge Co.

Turning now to the operating machinery, the main engine, placed amidships, operates the dredge bucket. This is an 18 × 24-in., double cylinder engine, with Stephenson reversing gear, and is compound geared to two 60-in. drums, with gear faces 12 ft. in diameter, and double frictions of the V-type, the male V's being of iron, and the female V's lined with lignum vitæ. The male V's are hollow, and to keep the friction faces cool water is circulated through them. The frictions are set up by steam compressors, so arranged as to apply pressure graduated at the will of the engineer. From the drums four 1¼-in., 37 wire strand, plow steel cables run to the clam shell. This clam shell bucket is itself of rather novel construction, as shown by Fig. 4. The bucket, as already stated, is of 10 cu. yds. capacity, and empty weighs over 30,000 lbs., and as the great depth of water precludes the use of poles, some especial precaution had to be taken to prevent it from twisting the cables together. The precaution adopted, as will be seen from Fig. 4, was to employ two sheaves, one placed on each side of the bucket, and to operate the bucket by two opening and two closing cables. As these four cables run over four sheaves on the boom, and the cables are made in pairs, with right and left hand lay, there is no tendency of the bucket to twist.

The secondary engines are two in number, each being a double cylinder engine, and one being placed aft and the other forward of the main engine. The forward engine is 10 × 12-in., and drives three friction drums for handling the forward anchor lines and six upright capstans on deck for handling lines and scows. The stern engine has 8 × 10-in. cylinders and drives the three friction drums for the stern anchors and two capstans on deck. A glance at the plan, Fig. 3, shows the method of driving the capstans. Each capstan is fitted with independent friction, brake and rachets.

Steam is supplied to all three engines by two Roberts water tube boilers. Each boiler has 46 sq. ft. of grate surface and 1,200 sq. ft. of heating surface, and is built for 250 lbs. steam pressure, although they are run at 125 lbs. pressure. All the engines are piped to a Wheeler Admiralty condenser and also to a free exhaust pipe, so that they can be run either condensing or non-condensing.

As stated at the beginning, the dredge has proved very satisfactory, working quickly, easily and smoothly, with plenty of power and abundance of strength in all its parts, and with great steadiness. As indicating its capacity the manufacturers write us as follows:

> Much of the material has proved harder to dig than was expected. There is a good deal of fine hard packed sand, sometimes in a stratum on top of the clay, and sometimes in pockets, scattered through it, and in this material, the bucket, heavy as it is, does not half fill, but in the clay it usually comes up heaped up. The clay weighs about 3,300 lbs. to the cu. yd., and as the bucket often comes up overflowing, with fully 15 yards, this makes a load of 80,000 lbs., which the machine handles easily at the rate of one bucket per minute in 65 ft. of water, without undue strain on the machine or any of its parts, or unusual effort on the part of the runner. The scows used average about 400 cu. yds., and the dredge loads ten or eleven scows per day in 65 ft. of water, though capable of doing more. It has often loaded scows in 30 and 40 minutes, and in soft clay has repeatedly loaded a pocket containing 60 cu. yds., with four buckets in 4 mins., in 60 to 70 ft. of water. It carries a crew of ten men and burns from four to five tons of coal per day.

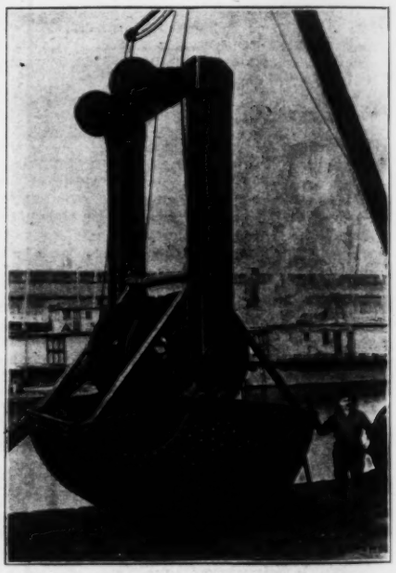


Fig. 4.—View of Ten-Yard Clam-Shell Bucket Used on Buffalo Breakwater Work.

Figs. 5 and 6 show the dredge in operation, and indicate the construction of the scows and the character of the material being excavated. The A-frame at the stern, which is shown in Fig. 5, was put on after the dredge was built, to handle the rear speed. This figure in some respects also gives a better idea of the upper works construction than does the drawing of Fig. 2. For the information from which this description has been prepared, we are indebted to the Osgood Dredge Co., the builders of the machine.

EXPERIMENTS WITH STALE AND PARTIALLY SEPTIC SEWAGE ON THE BROCKTON FILTER BEDS.

The operation of sewage purification plants would be robbed of half its difficulties if some cheap and economical method of sludge disposal could be devised. Where suitable land, and plenty of it, is available at low cost there is much to be said in favor of discharging the crude sewage on the beds without any previous attempt to remove the organic matter in suspension. The thin crust

of sludge that forms under low rates of filtration may be broken up occasionally, and perhaps raked off at longer intervals. In some cases it may be feasible to spade or plow it under, especially if the beds can be given a rest thereafter, or can be cultivated.

The conditions may be such, because of unsuitable land, limited area, or very strong sewage, that it is desirable to lighten the work or increase the rate of filtration on the regular filter beds by removing some of the suspended matters before the sewage reaches the disposal area. In England, this is commonly the case, and, generally, it is effected by means of chemical precipitation. In this country settling tanks, mostly of small capacity, and often mere screening tanks, have been used for sludge removal, when anything has been employed to lessen the work of the filter beds. The sludge thus removed has remained for final disposal, which is often quite troublesome. Frequently the practice is to discharge it onto sludge beds, either counterparts of the ordinary filter beds or composed of coarser material. Here much of the moisture in the sludge filters through the bed, and the remaining material is raked or scraped off, greatly reduced in amount and with little or no offense, but still presenting a considerable bulk to be disposed of. If the quantities are small the rakings can generally be buried in the earth, or spread upon land and plowed under, the permissible time between spreading and plowing depending upon the character of the sludge and the proximity of the land to dwelling houses. Theoretically, all the sludge that can be secured ought to be eagerly sought after by farmers for use as a fertilizer, but the history of sewage disposal presents a sad repetition of disappointed hopes and calculations in this respect.

Under the circumstances outlined above it is not strange that all schemes for the elimination or reduction of the sludge burden are watched with interest. Perhaps the most alluring of these at present is the Septic Tank (see Eng. News, Jan 13 and May 12, July 7 and Aug. 4, 1898), for which it has been claimed that besides eliminating the sludge problem it goes far towards producing an effluent that can be turned into any stream. These tanks are simply air-tight reservoirs, designed to hold about 24 hours' sewage flow, but with a constant discharge of clarified sewage. The bulk of the suspended matter is supposed to remain in the tank, where at least a part of the organic portion is attacked by anaerobic bacteria, broken up and changed to gaseous and dissolved forms.

The foregoing outline has been presented as an aid to the appreciation of the nature and significance of certain sludge disposal experiments made at Brockton, Mass., in 1898. (See Eng. News, Oct. 5, 1893; May 2 and 23, 1895; Feb. 27, 1896, and May 20, 1897, for a description of the plant and its operations.) This plant was visited by a member of the editorial staff of this journal on Jan 13, 1899, and through the courtesy of Mr. F. Herbert Snow, Assoc. M. Am. Soc. C. E., Tremont Building, Boston, the following information was secured. Mr. Snow was for a number of years city engineer and is now one of the Sewer Commissioners of Brockton. The sewerage and sewage disposal systems were designed and built by him, and the operation of the plant has been largely under his direction up to the present time. Mr. F. A. Barbour was assistant engineer on the construction of the beds, and until the close of 1898 was engineer and chemist in charge of their operation. Mr. G. E. Bowling, formerly assistant to Mr. Barbour, is now the chemist in charge of the beds.

The sewers of Brockton are on the separate plan. The sewage flows by gravity to a 600,000-gallon covered receiving reservoir, from which it is pumped through a 24-in. cast-iron force main, 16,643 ft. long, to the filter beds. Two 5,000,000-gallon pumps are provided. The pumpage during 1898 averaged about 600,000 gallons a day, but at present it is about 1,000,000 gallons. The sewage is strong, compared with that of other places. Its composition at different points in the disposal works is determined at frequent intervals in the well-equipped chemical laboratory at the filter beds. In the matter of a laboratory and regular examinations of the sewage the city of Brockton divides the honors with Worcester, these Massachusetts cities being the only two municipalities in the country maintaining such laboratories in connection with their sewage purification works.

The practice at Brockton, when the experiments to be described were initiated, was to pump the settled sewage from the reservoir to the filter beds late in the afternoon. When the sludge was reached, the agitator, or a by-pass through which sewage was forced back to the reservoir, was brought into play to stir up the sludge before it went to the pumps. The sludge is sufficient to fill only the first 2,000 lin. ft. of the force main, which has a storage capacity of 335,000 gallons, or over half the average daily flow in 1898.

All the sludge and a large quantity of sewage thus stands in the main between pumpings, which during 1898 was a clear period of over 20 hours. Likewise the sewage remained in the reservoir between pumpings, for an average of about 12 hours. Altogether, then, the sewage was at least 36 hours old when it reached the filter beds, and the sludge was somewhat older before it reached the beds devoted to it. The effect of allowing sewage to become stale before applying it to filter beds has been observed for years past at the Lawrence Experiment Station of the Massachusetts State Board of Health, as has been noted in the reports of the Board and at length in Engineering News of Aug. 4, 1898.*

In general the effect is similar to that produced by the septic tank. The suspended matter becomes more finely divided, and is reduced in amount by the conversion of part of it to the dissolved state. After these changes the sewage does not clog the surfaces of filter beds so badly, because it can more easily enter the interstices of the beds, where, in turn, it is more readily reduced by the bacteria, because that work is already well under way.

At Brockton, chemical analyses and the experience with the surfaces of the beds, showed most conclusively that the stale sewage was easier to filter than fresh. Thus the practical work on a large scale corroborated the experimental investigations at Lawrence, and added to the just regard in which the Lawrence studies are universally held.

It must be remembered, though, that the sewage, as applied to the beds, has not only had its organic matter partially reduced in form, but has also had it reduced in quantity by an average of 10 to 12 hours' sedimentation. The combined results of these processes enable the beds receiving the supernatant sewage to be operated without raking or scraping. The beds receiving the sludge were raked 14 times from Jan. 1 to June 30, 1898, there being about 12 tons of rakings per 1,000,000 gallons (8,350,000 lbs.) of applied sludge. In summer little or no raking of the sludge beds is required, but they are under cultivation then.

A sludge chamber was provided at the reservoir but it has never been used, it being considered far better to pump the sludge to the disposal area. Screening has been tried as a means of reducing the sludge, but has been given up.

In the fall of 1898 it was decided to operate the reservoir as nearly as possible like a septic tank. Accordingly, for the eight weeks between Sept. 6 and Nov. 29, no sludge was sent to the sludge beds. It was necessary to pump from the reservoir, and this of course led to the introduction of fresh air and some stirring up of the accumulated solids, both material variations from the septic tank practice. These facts should be kept in mind when comparing the results here with the claims made for the English septic tanks. The regular sewage sent to the beds each day had ample time for septic action to take place in it; but new supplies of air were introduced daily, and when the sewage was pumped from the tank the suction drew some of the solid matters with it. Such solid matter as remained in the reservoir appears to have staid at the top. At the end of four weeks there was a layer 14 ins. in depth of this floating matter at the farther end of the reservoir, diminishing in thickness to zero at about 10 ft. from the other end. The reservoir is 42 ft. wide, 118 ft. long, and has a storage depth of 12 ft. At the end of eight weeks this layer was 24 ins. deep at the influent end, and 10 ins. at the other. The material was a black, greasy mass, between peat and mud in consistency, with a

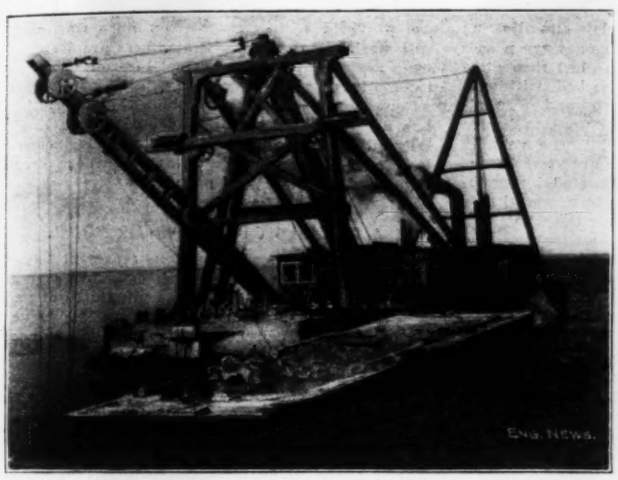


Fig. 5.—View of Dredge in Full Operation.

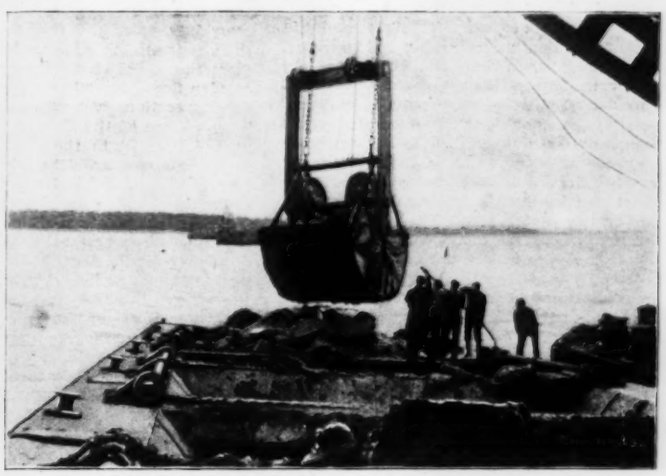


Fig. 6.—View of Bucket Ready to Dump Load.

FIGS. 5 AND 6.—VIEWS SHOWING TEN-YARD CLAM-SHELL DREDGE WORKING ON THE BUFFALO BREAKWATER.

Osgood Dredge Co., Albany, N. Y., Builders.

*Massachusetts Experiments on the Purification of Fresh, Stale and Septic Sewage," by Mr. H. W. Clark, Chemist of the State Board of Health of Massachusetts, Department of Water Supply and Sewerage.

green, leather-like surface. If a stick were thrust through it the hole made would fill with sewage and remain for a long time. This stuff always staid at the top of the tank, and observations indicated that there was no accumulation on the bottom, samples of the contents of the tank being collected at different depths and analyzed. It may be noted that in ordinary practice, a thin film of scum forms on the surface of the sewage of the tank in 24 hours.

While these septic experiments were in progress the sewage sent to the beds was much stronger than it has been before or since, and its character changed more than usual during its stay in and transit through the force main. Instead of materially increasing the dissolved organic matter in the applied sewage, and decreasing that in suspension, however, analysis showed that the dissolved albuminoid ammonia had increased but 11%, and the free ammonia only 22%, while the suspended albuminoid ammonia increased 139%, the oxygen consumed 34%, and the total solids, 38%.

At the conclusion of the experiments the sludge, which had been accumulating for eight weeks in the form of the floating mass before described, was stirred up and with some difficulty forced out of the reservoir and onto the sludge beds. Its total volume as delivered was 556,000 gallons, whereas the ordinary sludge flow for the same period would have been 3,190,000 gallons, the reason being, as above shown, that a large part of the solid matter had gone onto the regular sewage beds. The mass had a most horrible stench, and was very difficult to handle on the sludge beds. The water did not drain out readily and the men sent in to dig holes in the sludge to facilitate drainage were so sickened by the odor that they vomited.

The relative composition of the ordinary and the septic sludge, in parts per 100,000, was as follows:

	Sludge.	
	Ordinary.	Septic.
Total solids	182.86	308.18
Residue on evaporation	49.03	70.14
Loss from ignition	133.83	238.04

The composition of the rakings from the sludge beds before and during the septic period was as follows:

	Rakings.	
	Ordinary.	Septic.
Organic matter	17.57	20.27
Moisture	2.63	43.26
Sand	79.80	36.47
	100.00	100.00

The septic rakings were removed somewhat prematurely on account of the fear of freezing weather, and possibly because of the stench to which they gave rise.

The net result of the experiment, as measured by the organic matter to be disposed of, was a slight change in form and reduction in amount, but an increase of 60% in the cost of labor at the disposal area. This was largely due to the necessity for raking the sewage filter beds while they were receiving this septic sewage, no raking being required at other times. A mechanical separation of the organic matter was effected at the reservoir, but, as seen above, was of no particular advantage.

After trying different screening methods and the septic tank idea, the conclusion has been reached at Brockton that the best and cheapest means of sludge disposal, under their conditions, is daily application to special filter beds, with the raising of crops on the beds in summer and the burning of the rakings, when there are any. It is now proposed to erect a furnace at the beds, in which the rakings, and also weeds from the beds, will be burned.

As to the best crops to raise on the sludge beds, the opinion now is so favorably inclined to corn that it is proposed to plant nothing else in 1899. Sweet corn will bring a return of some $14 an acre; yellow corn about $3; and other crops generally less, owing largely to the difficulty of marketing them. In 1898 the crops raised were sweet and yellow corn, peas and turnips. The rakings from the sludge beds were plowed into some peaty land adjoining the disposal area, on which hubbard and yellow squashes were raised at a profit of 100%. Potatoes did well on some quite barren sandy soil, with the aid of rakings, about 40 bu. being raised on ⅛-acre.

Two drawbacks to farming as a means of sludge disposal are the limited period for which it is available, and the high price paid by the city for labor, $2 a day. The market gardeners and farmers in the vicinity, with whose products these crops must compete, paid nothing like these wages, and probably their hands work more hours a day.

About 100 apple and pear trees, of different varieties, were set out on the beds, just at the foot of the embankments, in 1898.

The experience at Brockton shows that the whole working of the regular sewage filter beds depends on their surface conditions, and these in turn upon the weather, winter being the governing factor. The beds have never yet been worked so high as to give poor results, so the limiting summer rate is unknown. As much as 140,000 gallons an acre has been applied in 35 minutes' time, and in five hours the bed was ready for another dose This was in dry, summer weather.

The beds are ridged and furrowed for winter use, which aids greatly the even distribution of sewage at all times, and especially in cold weather. Ice often spans nearly the whole space between the ridges, protecting the sand below and allowing the sewage to circulate there. The sewage passes from the outlet chambers to each bed through a wooden flume extending across the bed, with succeeding sections narrower than the one before, allowing some of the sewage to flow out each side of and parallel to the flume, while the velocity carries the rest by. The furrows are at right angles to the flume, and are intersected by cross-channels at intervals. This effects a remarkably quick and uniform distribution over the whole bed, in striking contrast to what the writer has seen on nearly all the level beds he has visited. Consequently, each part of the bed does its share of the work. The chances of deep freezing are also greatly lessened by the even distribution.

The effluent from the filter beds passes through two main underdrains to a small stream nearby, which flows through a cranberry bog. In winter this bog, in common with others, is flooded to protect the vines, a dam with proper sluice gates being provided for the purpose. At such times the effluent goes into the pond, adding largely to the volume of water it receives. The cranberries from this bog are said to be unusually large, well-flavored and abundant.

The composition of the partially clarified or settled sewage at Brockton, of the sludge, and the calculated composition of the two combined for the year 1897, as given in the report of the Massachusetts State Board of Health for that year, is as follows:

(Parts per 100,000.)

	Ammonia.		Oxygen consumed.	Chlorine.
	Albuminoid.	Free.		
Clarified sewage	0.5728	2.3636	3.67	6.29
Sludge	3.7578	4.4133	24.69	6.82
Calculated sewage	0.8964	2.5722	5.81	6.34
Effluent	0.0105	0.0911	0.11	4.80
Amt. removed by beds	0.8859	2.4811	5.70	....

The difference between the chloride of the calculated sewage and that of the effluent is principally due to dilution by ground water, which reduces the strength of the sewage by about 25%. At the filter beds of South Framingham there is a corresponding reduction of about 34%.

Further comment on these experiments is made on the editorial pages of this issue.

STANDARD PLANS FOR 130-FT. THROUGH TRUSS BRIDGES; NORTHERN PACIFIC RY.

(With full-page plate.)

We illustrate on our full-page plate this week another of the standard bridge designs adopted by the Northern Pacific Ry. to replace its old wooden bridges. For all spans up to 100 ft., it will be remembered by the readers of our former articles, plate-lattice girders were adopted. These girders have a solid plate web at the ends and a lattice web at the center and were fully described in our issues of July 8 and 15, 1897. For through spans between 100 ft. and 125 ft., inclusive, pony spans are used if dimensioned for mastodon engines, but if dimensioned for consolidation engines the plate-lattice girders are used up to 110 ft. span. About the same limits of span are used for all deck bridges, starting with semi-pin connected spans, similar to the pony spans, at 110 ft., if dimensioned for mastodon engines, and at 120 ft. if dimensioned for consolidation engines. Details of the 120-ft. pony truss spans were published in our issue of Jan. 5, 1898. The shortest purely through span used is 130 ft, and the details of this are shown on our full-page plate this week.

The characteristic feature of this span is that the bottom chord is a stiff section throughout its entire length. Fig. 1 gives the details of the trusses and lateral bracing; Fig. 2, details of the roller and fixed bearings, and Fig. 3, details of the floor beams, stringers and track. The drawings show all members and dimensions fully and will not be described further.

For standard 130-ft. through spans the specifications call for the following material: All eye-bars, pins and rollers, medium steel; all other members, soft steel, unless otherwise noted on the drawings; all field rivets, wrought iron. All field rivets and machine-fit bolts are ¾-in. in diameter unless otherwise stated on the drawings. The diameter of the pins given on the drawings is the finished diameter. All pins except the end pins are provided with wrought-iron filler rings and soft steel Lomas nuts. All members are designed for a rolling load of two typical 146-ton mastodon locomotives.

For the information from which this description has been prepared we are indebted to Mr. K. E. Hilgard, M. Am. Soc. C. E., formerly Engineer of Bridges, Northern Pacific Ry., under whose direction the designs were prepared.

A PORTABLE COMPRESSED AIR MOTOR.

The accompanying illustrations represent a type of compressed air motor which embodies several novel features aside from its compact form and portability. It is intended to be used wherever compressed air can be obtained and a compact motor is needed to drive portable drills, reamers, tapping machines, etc.

The motor complete on its base, as shown in Fig. 1, in which one side-plate has been removed to show the interior construction, weighs 300 lbs., and occupies a space 20 ins. long, 18 ins. wide over wheels and is 19 ins. high. With an air pressure of 80 lbs. it is capable of developing 2 HP. It is provided with a 6-in. pulley (P) on one end of the shaft, while at the other end is a projecting coun-

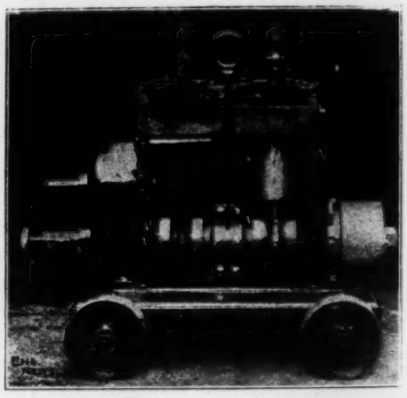


Fig. 1.—A Portable Compressed Air Engine. Stow Flexible Shaft Co., Philadelphia, Pa., Makers.

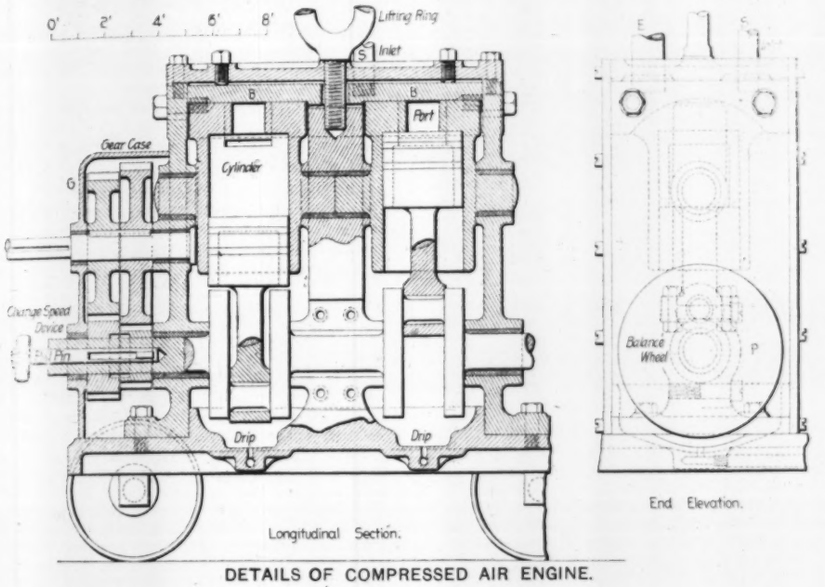
ter-shaft capable of running at two speeds, and on which can be slipped a patent universal joint flexible shaft coupling.

The maximum speed of the engine, and hence the pulley speed, is 1,400 revolutions per minute with a pressure of 80 lbs.

The construction of the motor is extremely simple, and consists of a substantial cast-iron base-plate 20 × 14 ins., Fig. 2, upon which, in a water and dust tight box, 12⅝ × 7⅛ × 13 7-16-ins., are two small oscillating cylinders, having a diameter of 3 ins. and a stroke of 3 ins. The two piston rods connect directly to a solid forged shaft, 1¼ ins. in diameter, which has three good-sized bearings, two in the end plates, and one in the center column, which is cast with the bed plate. This column also contains the inner trunnion bearings

for the cylinders, and into its top is screwed a heavy lifting ring, which is used to support the motor over the work when desired, or it can be used to transport the motor about the shop if there is a traveling crane. The outer trunnion bearings are in the end plates, as will be seen in both figures.

The back of the cylinders, corresponding to the cylinder head, is turned concentric with the trunnion to present a convex cylindrical face to the valve block (B), which is a cast-iron block with a concave cylindrical face corresponding to the outer ends of the cylinders and containing properly-spaced inlet (S) and exhaust ports (E). This valve block is held in place against the cylinder ends by suitable springs and adjustment screws. The gear case (G) at the end opposite the pulley contains two pairs of gears, a 2-in. and a 5¾-in., and a 2¾-in. and a 5-in. The smaller gears are mounted upon the engine shaft, which is hollow at the end, and contains a slip key, provided to lock either gear to the engine-shaft. The larger gears are firmly keyed to a short counter-shaft, from which power to operate the flexible shaft is taken. At the maximum speed of 1,400 revolutions per minute, there are, therefore, two shaft speeds, 485, 773, according to the pair of gears in operation, which is controlled by simply pushing in or pulling out the slip key. Any other speed can be obtained by throttling the air supply, with, however, a corresponding reduction in power. While designed primarily to operate flexible shafts, the motor is also arranged to take the place of any small engine, and the driving pulley admits of its use for a variety of purposes, for example, it can be placed near and belted directly to a polishing machine, an emery grinder, brass lathe, etc.



DETAILS OF COMPRESSED AIR ENGINE.

The motor is being built and introduced by the Stow Flexible Shaft Co., 26th and Callowhill Sts., Philadelphia, Pa. We are indebted to Mr. Frederic Schoff, the proprietor, for the information from which this article was prepared.

COSTS OF OPERATING PRIVATE AND MUNICIPAL ELECTRIC LIGHTING STATIONS IN ENGLAND.

Analysis of the operating costs of the principal electric lighting concerns of England, for the years ending March 31, 1897, and March 31, 1898, is given by the London "Electrician," in its issue of Jan. 6. The returns from 33 stations operating under municipal control and 25 stations operated under private control are included. Full particulars of each of the 58 stations are given in tabular form so that a detailed understanding can be had of the operation of each station. We have arranged the averages of the tabulated data in the accompanying table so that a comparison of the different items for private and municipal plants can be readily made. The headings in order down the left hand column have the following meanings:

The figures opposite Output are to be multiplied by 1,000, i. e., in 1896 the municipal output was 466; 466 × 1,000 = 466,000 units, the unit in each case being the kilowatt-hour.

Units sold per 8-c. p. capacity refers to the number of 8-c. p. lamp the station could operate. The figure 15.7 in the first column means simply that 15.7 kilowatt-hours were sold for every 8-c. p. lamp the station could have operated.

The values given for the Load Factor are percentage ratio of the output, in units sold, to an output equal to the maximum demand on the station continued without intermission during the whole year; in other words, it gives the ratio of the actual output (in units sold) to the maximum demand (in kilowatts) multiplied by a constant (8,760) which is the number of hours in a nominal year.

Revenue per unit sold is self-explanatory, as are also the remaining headings.

The column headed Per cent. Increase or Decrease, refers to the change in the particular item during the two years 1896, 1897, and (+) before the values means that the expenditure in 1897 for that item was greater by the percentage given than the expenditure for the same item in 1896. Referring to the table and considering first those stations operated under municipal control it will be noticed that the output (units sold) for 1897 was over 40% greater than in 1896, the load factor improved 6%, while the revenue to the municipality fell off 9.23%. Expenditures for fuel decreased slightly, only 6.24%, while the cost of oil, waste, water and engine room stores decreased over 25%. Wages, repairs and maintenance, cost of generation, distribution and works all fell off in 1897 in amounts varying from 10% to 17%. Management and property dropped 22.7%; while total cost of production per unit decreased 14.3%.

In the case of the private plants the same items show an increase or decrease. Increased output and load factor, with a decrease in the cost items, are noticed the same as with the municipal plants, although the increase in output and the decrease in costs are not as great as in the former case. Comparing directly the item of the municipal and private plants for 1897 we notice that the revenue per unit sold stands 9.54 cts. to 11.96 cts. in favor of the private plants. Fuel, wages at generating station, repairs and maintenance, generation, distribution and works all cost more for the private plants and, therefore, the total cost to the manufacturer is 5.32 cts. to 6.02 cts. per unit sold in favor of the municipal plants. The ratio of these total costs to the revenues per unit sold give 55.8% and 50.1%. In other words the cost of production per unit in the case of the municipal plants was 55.8% of the total revenue per unit sold, while the cost in the private plants was 50.1% of the revenue per unit. Here is noticed a difference of 4.9% in favor of the private company. This difference, however, assumes another meaning when the revenue per unit sold in the two cases is compared. The municipal revenue is 9.54 cts. per unit sold and the private revenue, 11.96 cts., meaning that the latter charged on an average 25.4% more per unit sold.

In the fourth column of the table in each case are given the lowest values reported for the various items and these are of use only to indicate what may be regarded as practical limits of cheapness, for the present at least.

Comparison of Operating Costs of English Private and Municipal Electric Lighting Plants.

	Operated by Municipality.				Operated by Company.			
	1896.	1897.	Per ct.*	Record for '97.	1896.	1897.	Per ct.*	Record for '97.
Output per 1,000 units sold (1 unit = 1 K-W.hr.)	466	655	+ 40.8	3,435	676	867	+ 28.0	4,356
Units sold per 8 c. p. lamp capacity	15.7	18.8	+ 19.8	37.0	17.4	19.4	+ 12.0	32.7
Load factor = units sold × 100 / Max. demand × 8,760	8.78	9.30	+ 5.92	14.5	10.3	11.0	+ 6.8	21.7
Revenue per unit sold	10.42	9.54	— 9.23	6.32	12.40	11.96	— 37.0	8.98
Cost in cts. per unit sold:								
Fuel	15.82	1.508	— 6.24	.640	1.906	1.776	— 7.3	.504
Oil, waste, water and engine-room stores	.360	.286	— 25.9	.078	.306	.258	— 16.0	.106
Wages at the generating station	1,406	1.202	— 17.0	.344	1.416	1.324	— 7.0	.596
Repairs and maintenance at station	.496	.450	— 10.2	.100	.602	.554	— 8.7	.314
Generating	3.84	3.44	— 11.6	1.42	4.32	3.98	— 8.6	2.12
Distribution	.338	.296	— 14.2	.010	.432	.376	— 15.0	.040
Total works	4.46	3.98	— 12.1	2.16	4.64	4.18	— 11.0	2.04
Management and property	1.642	1.338	— 22.7	.728	2.12	1.844	— 15.0	.906
Total	6.08	5.32	— 14.3	2.88	6.76	6.02	— 12.0	3.08
Ratio of total costs to revenue, %	58.7	55.8	— 5.20	34.2	54.9	50.1	— 9.6	29.1

* + Increase. — Decrease.

THE BRISTOL STEEL BELT LACING.

A recent improvement has been made in this well-known and extensively used belt lacing and is made clear by the accompanying cuts. Fig. 1

Fig. 1.—Original Form of the Bristol Steel Belt Lacing.

shows the style of lacing first brought out by the Bristol Co., some ten years ago, and adapted especially for leather belts. The new lacing, shown by Fig. 2, differs from the old somewhat as staggered riveting, in a riveted joint joining two steel plates, differs from ordinary single riveting. This new fastening is equally applicable to leather,

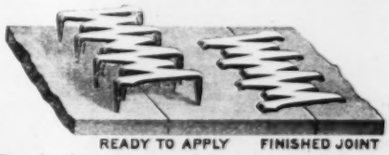


Fig. 2.—New Form of Bristol Steel Belt Lacing.

fabric or rubber belts, and for joining belts where great strength is requisite it is of especial value. The method of applying the lacing is evident from the engraving, and it will be noted that no special tools are necessary. The Bristol Co., of Waterbury, Conn., the manufacturers of this lacing, offer to send samples of it free on request.

THE LARGE CAR PROBLEM is being handled in a summary way by the Southern Pacific Co. A circular from the company's headquarters at San Francisco, under date of Jan. 20, announces that on and after Feb. 20 the Pacific system of the company and the Santa Fe Pacific and Southern California Rys. will refuse to accept at interchange points freight cars over 40 ft. long, inside measurement.

A CURIOUS MATHEMATICAL PROBLEM.

For some time past those interested in marksmanship have been discussing the problem of finding the true center of a group of shots upon a target, or, in other words, that point in a group of shots from which the sum of the distances to each individual shot would be a minimum. At first sight the problem seems a simple one, but when it is attempted the solution is found to be by no means evident.

In a recent number of "Shooting and Fishing," Mr. A. L. A. Himmelwright, C. E., contributes a graphical solution of this problem, which we reprint below. Mr. Himmelwright gives the credit for the solution to Mr. John A. Roebling, C. E. He states that Mr. Roebling found the analytical solution to be one of much difficulty, involving equations of a degree equal to the total number of shots. The position of the desired center was found to depend on angles and not on distances. The essential part of the graphical solution found by Mr. Roebling we reprint in full as follows:

In the case of two shots, the point sought lies anywhere in the line joining the two shots. In the case of three shots, the point sought is at the intersection of three lines, making an angle of 120° with each other and passing through the three shots. In the case of four shots, the point sought is at the intersection of the two lines joining diagonally opposite shots. The solution for finding the desired point in the case of five or more shots is as follows:

Assuming that a score of ten shots has been fired on a target, a piece of white drawing paper should be placed under the target and the latter fastened down over the drawing paper with thumb tacks to a board or table. With a pair of dividers set off a distance equal to half the diameter of the oullet and place one leg of the dividers as near

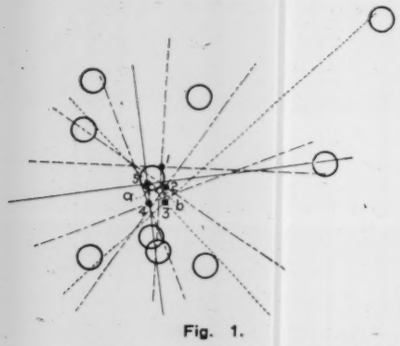


Fig. 1.

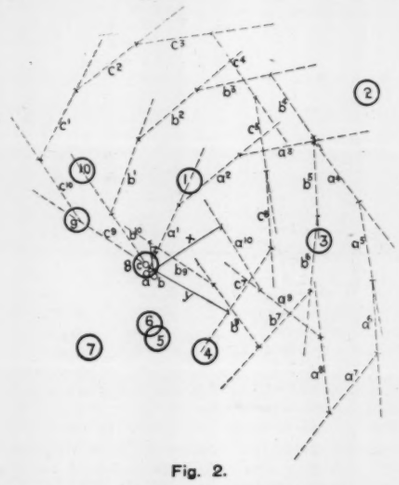


Fig. 2.

A GRAPHICAL METHOD FOR FINDING THE TRUE CENTER OF A GROUP OF SHOTS.

the center of the bullet hole as can be determined by inspection. Describe a circle and note whether the other leg of the dividers coincides with the outside marks of the bullet, either the discoloration caused by the lubricant or the breaks caused by the bullet in the target. In this way the bullet hole can be accurately centered. When this has been done, prick a hole through the white drawing paper under the target in the center of the bullet hole, and repeat this operation for each of the shots of the score. Now remove the original target and draw a small circle with a lead pencil round the centers of the shots, so as to locate them conveniently in the subsequent operations.

Next take a piece of tracing paper or tracing cloth of suitable size and draw two lines at right angles intersecting near its center, pricking a hole at the point of intersection. Lay this tracing paper over the group and move it about until it gets into a position having five shots on each side of each of the two lines, as, for example, the position shown in the intersection 1 in Fig. 1. Take a pencil or pin and mark the point of intersection through the tracing paper on the drawing paper. Next move the tracing paper into another position which will, as before, divide the group, so that five shots will be on each side of the two lines, and mark a second point. Continue this operation until six or eight points have been thus located, as shown by the round black dots in Fig. 1, marked 1, 2, 3, 4, 5, etc., which points will mark what we will call the probable area in which the desired point will be found. Next select two trial points well within and near the center of this probable area; as, for example, points marked a and b (indicated by arrows).

To avoid complication in the drawing, we will transfer these two points, a and b, to Fig. 2, and complete the solution. Beginning at trial point a, draw a line from a to any of the shots; as, for example, the one marked 1. Take a pair of dividers and set off an arbitrary distance; as, for example, one inch, as in this case, and mark this distance from a on the line a^1. Next take the direction from trial point a to another bullet hole 2, and draw a line parallel to this direction from the point marked on the line a^1. Set off on this line the same distance with the dividers as in the case of a^1, which will give us a^2. Then take the direction from trial point a to another bullet hole 3, and draw a line parallel to this direction from the point set off on the line a^2, which gives a^3. Continue this operation, giving a^4, a^5, a^6, a^7, a^8, a^9 and a^{10}, as shown in Fig. 2. From the end of the line a^{10}, draw the closing line x to the trial point a, which completes the polygon of trial point a.

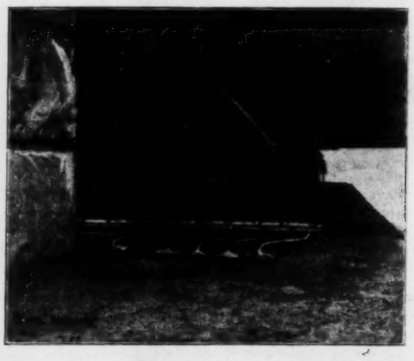
Now, take the second trial point b and start with another bullet hole, as for example 10, to avoid coincidence of polygons. Draw the polygon similarly for trial point b, as we did for trial point a, drawing the closing line z of the polygon to the trial point b. Where the lines x and z intersect, if the drawing is accurate, will be the desired point; that is the point of least string measurement.

On account of the liability of making small errors, which would be greatly multiplied in a polygon of so many sides, it is desirable to prove a point so found, and, in order to do this, another trial point may be assumed within the probable area, and near trial points a and b, and a similar polygon drawn from such third trial point. If the closing line intersects in the same point as the closing lines x and z, the drawing is proved to be correct. Because the shot marked 8 comes within the probable area and very near to trial points a and b, we have assumed the center of this shot as the third or check trial point, and drawn its polygon, the closing line being the line y, which passes through the intersection of x and z, proving that all three polygons have been correctly drawn.

In practice, the solution of this problem will not be found as complicated as it appears to be in the figures here given. All the lines shown on Fig. 1 would be entirely eliminated, as, by the use of the tracing cloth, only points 1, 2, 3, 4, 5, etc., would be marked.

A PECULIAR BRIDGE FAILURE.

A curious bridge accident resulting from poor detailing, coupled with the familiar neglect of obstructed and rusted expansion bearings, is illustrated by the accompanying engraving, made from a photograph taken of one of the expansion end bearings of the High and Main St. bridge at Hamilton, O. This bridge is a Baltimore truss highway bridge, with a 40-ft. roadway, and two 10-ft. sidewalks, and has a total width over all of 66 ft. The roadway is covered with asphalt blocks 4 ins. thick, laid on buckle plates, concrete and sand, and it provides for two street-car tracks located adjacent to the trusses. The span has a dead load of probably about 1,650 tons, and it was built by the Toledo Bridge Co., of Toledo, O.



View of I-Beam Roller Bed of Highway Bridge at Hamilton, O., Showing Bending of I-Beam Webs Due to Failure of Expansion Bearings to Operate.

The accident illustrated occurred Jan. 2, 1899. As will be seen, the bearing plate, or bolster, between the roller bearing and the abutment masonry was built of two layers of 12-in. I-beams, one superimposed on the other and at right angles. The I-beams in the top layer were laid parallel with the center line of the bridge, thus bringing those of the bottom layer perpendicular to the center line, and to any longitudinal pull caused by contraction of the ironwork. The intervals between the I-beams were not filled or braced in any manner, so that only the aggregate strength of the webs of the lower beams against bending was available to resist such a longitudinal pull. Owing to the rollers having become packed with silt and drift during high water, which blocked and rusted them tight, they were prevented from doing their duty, and the contraction of the metal during the recent cold weather caused the longitudinal pull to be transferred through the rollers and upper I-beams to the webs of the beams beneath. Their strength was not sufficient to resist the pull until the rollers should slide on their bearing and they, therefore, buckled in the very uniform and symmetrical shape shown by the illustration. The failure caused the shoe to drop about 8 ins. The shock and racking effect caused the rupture of several of the top laterals, leaving the span in a rather bad shape.

As this design of bolster has been employed in several cases which have recently come to our notice, the accident illustrated furnishes an instructive object lesson. The Osborn Co., Civil Engineers, of Cleveland, O., whose experts investigated the accident, inform us that this is the second case recently examined by the company where failure to provide proper facilities for expansion has resulted in damage to a valuable bridge. For the information from which this description of the accident has been prepared we are indebted to Mr. Bernard L. Green, of the Osborn Co., Cleveland, O., and to Mr. L. A. Dillon, County Surveyor, Butler Co., Ohio.

THE EFFECT OF SIZING ON THE REMOVAL OF SULPHUR FROM COAL BY WASHING.*

By Charles C. Upham,† M. Inst. M. E.

Not long ago a few acres of coal land in the Connellsville region of Pennsylvania were sold at the rate of $1,500 per acre. While this was doubtless a "fancy" price, affected by some consideration other than that of the simple value of the coal in the tract, it may fairly be taken as an indication of a progressive and already perceptible diminution in the economically available coal resources of that famous region. This present and prospective development emphasizes the commercial importance of producing, from the inferior coals of other districts, coke suitable for use in the blast furnace.

Many of the bituminous coals of the United States would meet this requirement if sufficiently freed, before coking, from slate and sulphur, and, so far as the removal of slate is concerned, the problem is not specially difficult. There are many forms of trough, jig and gravity washers which easily and cheaply reduce the slate from as much as 20% in the coal to as little as 8% in the coke. But to reduce the sulphur from 4% in the coal (a proportion sometimes encountered) to 1% or less in the coke (the proportion demanded by the furnace managers) is not so easy.

Of the three forms in which sulphur usually exists in coal (hydrogen sulphide, calcium sulphate and pyrite), the pyrite is the one to be removed, as far as possible, by mechanical treatment before coking. Hydrogen sulphide, being volatile, is expelled in coking; calcium sulphate, or gypsum, is not practically removable by preliminary treatment, and remains in the coke, while pyrites (the most abundant source of sulphur in coal) may be, to some extent, oxidized, with removal of its sulphur, in the coke oven, but can be, by reason of its high specific gravity, more advantageously removed by mechanical treatment before coking.

It is the purpose of this paper to call attention to an element in this preliminary treatment which is, according to my observation, very generally neglected in the washing of coal in this country.

*Condensed from a paper read at the Buffalo meeting of the American Institute of Mining Engineers, Oct., 1898.

†2 Cortlandt St., New York city.

When coke ovens are located at the mines the slack produced in the ordinary screening of the coal for market is very commonly washed and coked. But in many cases the coal is treated just as it comes from the screens—in pieces varying all the way from an inch cube down to dust, while in few, if any, cases is the slack separated into more than two or three sizes. Of course, in the process of separation by specific gravity pieces of coal or slate with adhering pyrites, having an average specific gravity perhaps midway between coal and slate, or even very nearly that of the clean coal, may go to the coal side of the apparatus; but a preliminary crushing and sizing, reducing all pieces below a given maximum diameter (to be determined, doubtless, for each coal separately, but to be probably not more than ¼-inch diameter for any coal requiring washing) will separate all the pyrites from the coal or slate, leaving each to the action, in the process of washing, of its own specific gravity. Experimental illustration of this proposition is given below.

Again, a portion of the pyrites in coal as it comes from the mines seems to be in particles finer even than those of the coal dust and constituting an impalpable powder. This "flour pyrites" floats in air or water. The following experiments were made to test its relative fineness:

A sample of finely crushed coal was passed over a 20-mesh screen. The material remaining on the screen contained, by analysis, 1.11%, while that which passed through contained 1.49% of sulphur.

Again, a sample of coal-dust was submitted to suction from a centrifugal blower. The part thus taken up and deposited in a separate chamber contained 1.36%, while the remaining portion, not acted upon by the suction, contained 1.14% of sulphur.

These results, especially in view of the higher specific gravity of the pyrites, seem to prove conclusively that it pulverizes more finely than the coal. The practical importance of this fact will be evident, when it is considered that, in many plants where coal slack is washed for coking, the washed coal is passed over screens and the water is drained off, to be returned to the washing apparatus and used again. Obviously, this practice cannot give the best results; for on the one hand, some of the "flour pyrites" will be left on the coal in draining, and some will be carried back by the water, to accumulate by successive operations, and ultimately pass off with the coal.

With regard to both the foregoing suggestionss, but chiefly as to the importance of the finer crushing of coal before washing, the following experiments may be of interest: They were made upon coal from the Pittsburgh seam, and on a working scale, with samples of several tons. The apparatus employed was a trough washer, of a type in general use.

A sample, A, of ordinary slack, and a sample, B, of the same slack, crushed to particles 3-16-in. and less in diameter, were treated in the washer and the cleaned material was analyzed. The analysis of the original slack and of the result from each sample, were as follows:

	Ash. Per cent.	Sulphur. Per cent.
Unwashed slack	10.51	2.876
A, washed	7.97	2.230
B, "	4.56	1.188

The result from sample B would make coke carrying about 1% of sulphur.

Another sample of Pittsburgh coal, containing 11.95% of ash and 2.121% of sulphur, was crushed to about 20-mesh size, and washed as before, the result showing 4.86% of ash and 1.046% of sulphur. The coke made in a crucible from this sample contained 0.836% of sulphur—an amount well within the commercial limit.

In this experiment, the coal and water, after passing through the separator, were led into a settling bin, where the coal was deposited at the bottom, while the water (and with it the "float pyrites") was conducted away from the top in a stream half an inch deep. So much of the fine pyrites was carried on the surface of the water that the glistening particles could be readily skimmed off with the hand.

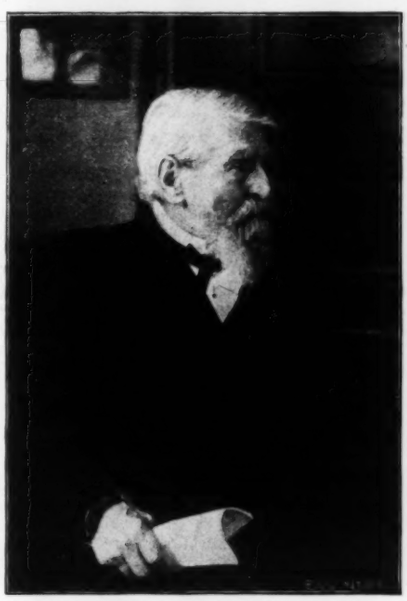
Additional experiments made with other coals have shown that the critical size at which an almost complete division of the coal and pyrites takes place varies with coals from different districts and beds. In designing plants for coal washing, the proper fineness of crushing should be determined beforehand by careful experiment.

As a result of the observations and experiments above described, I have been led to believe that, by due observance of the conditions indicated, coke of good quality could be made from many coals not now considered as suitable for that purpose, and many inferior cokes now in the market could be greatly improved.

GEORGE SEARS GREENE.

Gen. George S. Greene, Past President of the American Society of Civil Engineers, and one of the oldest civil engineers in the United States, died of old age at his home at Morristown, N. J., on Jan. 27, 1899. To but few men is it allotted to live so long and so active a life as did Gen. Greene. Had he lived until May he would have been 98 years of age, and nearly 70 years of his life were spent in active professional work. Although educated and trained at West Point as an officer in the regular army, Gen. Greene's greatest work, probably, was accomplished in civil pursuits in the practice of his chosen profession of engineering. He was one of the many distinguished civil engineers which the famous military school has given to the nation; and as a man, as a soldier and as an engineer he did honor to the best traditions of that historic institution. He leaves the record of a well spent life, and to those who knew him personally, the memory of a sound and manly and gentle character.

George Sears Greene was born in the little village of Apponaug, in the town of Warwick, R. I., in May, 1801, and was able to trace his ancestry back to 1635, when John Greene came from Salisbury, England, and settled in Warwick, R. I. Gen. Nathaniel Greene, of revolutionary fame, was also a descendant of this same John Greene. When 18 years of age Geo S. Greene was appointed to the military academy at West Point, where he remained four years, graduating in 1823 and standing second in his class. He remained at the academy for about a year as assistant professor



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of mathematics and then went to the Artillery School for Practice at Ft. Monroe, Va., as assistant instructor in mathematics, where he remained but four months, to return to West Point in October, 1824, where he continued teaching mathematics and engineering until the spring of 1827. After leaving the academy Lieut. Greene was assigned to garrison duty chiefly at New England posts until the fall of 1835, being promoted to a First Lieutenancy in the 3d Artillery in May, 1829. This was the highest rank reached by Mr. Greene in the regular army, as he resigned his commission on June 30, 1836, to engage in civil pursuits.

From the time of his resignation from the regular army until the outbreak of the civil war Mr. Greene practiced as a civil engineer in New England and later in New York city. From 1847 to 1852 he was chief engineer of the Portland & Kennebec R. R., in Maine; in 1852 he located the Albany & Susquehanna R. R., in New York, and from 1852 to 1856 he was chief engineer of the Providence & Bristol R. R., in Rhode Island. In 1860 Mr. Greene began his first work on the Croton water supply for New York city, with which work his name was to be so long associated in responsible positions. From 1860 to 1862 he was the engineer in charge of the Croton Water-Works Extension and of the Croton Reservoir in Central Park in New York city, which latter was perhaps his most important engineering work.

At the opening of the civil war Mr. Greene was in his 61st year, but he was among the first to offer his services to the country and he went to the front as Colonel of the 60th New York Volunteers in January, 1862. In the following April he was made a Brigadier-General of volunteers and was in command of his brigade at the battles of Cedar Mountain, Antietam, Chancellorsville and Gettysburg. In September, 1863, Gen. Greene was transferred to the Army of the West, and shortly afterward received a wound which disabled him from active service until January, 1865, when he joined General Sherman's army in North Carolina. He was brevetted Major-General of Volunteers on March 13, 1865, and was mustered out of the volunteer service in April, 1866.

Upon his return to civil life Gen. Greene renewed his civil engineering practice, being connected with the Croton Water-Works Extension as engineer in charge, and later as Chief Engineer and Commissioner of the Croton Aqueduct Board, remaining in office until April, 1870. He then became Assistant Engineer of the Department of Public Works of New York city until called to Washington as Chief Engineer of Public Works in 1871. During his two years' work in that city, Gen. Greene drew up the comprehensive plans for Washington's sewerage system. He then returned to New York, where he engaged in consulting and advisory practice, and was connnected with such important works as the park improvements of New York city and the water-works of Detroit, Mich., and Troy, N. Y. In 1875 he was elected President of the American Society of Civil Engineers, which office he held for two years. In 1881 he was made a member of the Board of Visitors of the U. S. Military Academy.

By a special act of Congress passed in 1894, George Sears Greene's regular army rank of First Lieutenant was restored to him and he was placed on the retired list of officers. At the time of his death he was the oldest surviving graduate of West Point, the oldest commissioned officer in the United States Army, and, it is believed, the oldest Lieutenant in the world. Gen. Greene in private life was of a very sociable and companionable disposition. Since 1868 he had been a member of the Century Club of New York city, and during the late years of his life seldom a day passed that he did not spend an hour or so both day and evening in its rooms meeting old friends and reading the current periodicals. Gen. Greene's hale and hearty old age is well shown in the portrait, which we present herewith, and which is engraved from a photograph taken on his 97th birthday. He is survived by three sons, Gen. Francis V. Greene, M. Am. Soc. C. E., a graduate of West Point, who commanded the forces in Manila under Gen. Otis, and who has been for many years President of the Barber Asphalt Paving Co.; Geo S. Greene, Jr., M. Am. Soc. C. E., for many years Chief Engineer of the Department of Docks, of New York city, and Maj. Chas. T. Greene, U. S. A. (retired).

NOTES FROM THE ENGINEERING SCHOOLS.

University of Wisconsin.—Prof. J. B. Johnson, of Washington University, St. Louis, well known to engineers the world over for his valuable contributions to engineering literature, has been elected Dean of the Department of Engineering of the University of Wisconsin. We notice in the report of President Adams, published in the Biennial Report of the Regents, that the Department of Engineering is already badly overcrowded. An analysis of the air in the largest lecture room showed carbonic acid to the extent of "17 parts in 1,000, whereas the health limit established by the best authorities is 7 in 1,000. [Probably both figures are errors of the pen; the health limit is 6 to 8 parts in 10,000.] Students have fainted and been carried from the room. The steam laboratory is so crowded that efficient work in it is "manifestly impossible." "The most urgent necessity exists for the entire withdrawal of the College of Engineering from Science Hall. This can only be done by the erection of a new building." We have not yet any information to the effect that a new building for the College of Engineering is under construction; and Prof. Johnson's appointment as Dean of the Department instead of relieving the overcrowding will be apt to increase it.

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Those who are looking to the septic tank as the next great forward step in sewage purification will do well to consider the experience of Brockton with a partial application of the septic principle. A detailed account of experiments at Brockton extending through eight weeks is given elsewhere in this issue, prepared from notes taken at the disposal works by a member of the editorial staff of this journal. The experiments are discussed so fully elsewhere that little need be said here except to call attention to them, and to caution our readers not to draw too sweeping generalizations from them. The experiments were not designed to prove anything for or against septic tanks, further than to decide whether an extension of the septic methods which already prevailed to a large extent at the works would be advantageous. The conclusion was adverse, but perhaps this was due to the fact that the septic methods were already pretty fully utilized rather than to any fault of the system. It is questionable whether the full septic idea was carried out, since each day's pumping from the reservoir admitted a fresh supply of air and disturbed the accumulated suspended matter so much as to add some of it to the sewage drawn through the pumps. But this air could affect only the surface of the sewage, which was covered by a thick scum, so it may have made little difference one way or the other. The experience at Brockton before the septic experiments were made seem to indicate clearly that under the conditions existing there intermittent filtration may be greatly aided by applying the sewage to the beds in a stale rather than a fresh condition and after previous settlement; also that the resulting sludge can be treated with ease on special sludge beds, but the rakings from such beds, if large quantities of sewage are involved, will remain for final disposal. They may be plowed into land, or burned in a sludge furnace. The value of trained engineering and chemical superintendence at sewage disposal works is also plainly shown by the operations at Brockton, and the information they are adding to our knowledge of sewage purification.

In commenting, in our issue of Oct. 27, 1898, upon the "Modern Naval Engineer," it seems that we unintentionally did an injustice to the Engineering Staff of the English Navy, by using data contained in a foreign technical journal. The statement was there made that the engineer in the Royal Navy goes directly from civil life to the engine room; and while he there slowly picks up the practical part of his profession he has little opportunity to obtain that high technical training necessary for the efficient performance of all the duties of the engineer officer of a modern warship. The journal referred to certainly made out a bad case for the engineering staff, as contrasted with the English line officer, in lack of executive power over subordinates; congestion in promotions; inadequate relative pay and position, and in the lack of proper representation in the higher grades of the service. In fact, the main arguments employed are the same with which we are familiar in our own naval personnel discussion; though the English engineer officer contents himself with asking for a separate corps of Royal Naval Engineers, classed as a military branch of the service and having executive power in their own department. The senior officer of this corps on a ship would be responsible to the Captain direct for the discipline and conduct of the engineering staff, and the officers of the Corps would rank with the Deck, or line officers according to date of commissioners. Other recommendations called for adjustment of relative pay, retirement of engineers of Commander rank at 50 years of age, increase in the force in the engine room, etc.

The full statement of the position of engineer officers in the Royal Navy, and of the measures proposed for relief, have been forwarded to us by an officer of high rank in that branch of the service. This officer protests against the implications in our editorial that the engineers of the English Navy have little opportunity for technical training of the higher grade; and in support of his contention he sends us an address made to the Institution of Junior Engineers by Sir William H. White, K. C. B., Assistant Controller of the Navy and Director of Naval Construction. This officer is certainly in a position to know whereof he speaks; and we are glad to abstract that part of his address relating to the education of naval engineers, with the hope that it may remove any false impression conveyed by our former article. Naval Constructor White describes the system of training for the staff of Constructors and Naval Engineers in the English Navy, as follows:

> Entrance to the course is by competitive examination, the standard of which is high for the age of the candidates, and furnishes a good test of general education. Then follows a period of training in a College attached to one of the Dockyards, a part of the time being devoted to educational work, and the remainder to practical work in the shipyard and steam factory. At the conclusion of the course a certain standard of proficiency has to be obtained in both scientific and practical subjects. The best students in each year are given a higher course of training at the Royal Naval College, returning to the Dockyards during the vacations. When they complete this further course they are ready for professional work and at once receive appointments.

Unfortunately, no time is stated for the period of training, and the "certain standard of proficiency" in both scientific and practical subjects is left as a somewhat uncertain quantity. Sir William says, however, that this system, with certain modifications, has been in operation for half-a-century, and "with eminently satisfactory results," and from his point of view it is certainly sufficient. But it is also evident from other portions of this address that he speaks rather as a naval constructor than as a naval engineer; and he goes on to say that men so trained fill the highest professional offices in the Admiralty service, design and construct merchant ships, as well as naval vessels, and act as professors or teachers in technical schools. His position is that the ideal system of training is that which gives a scholastic education side by side with the preliminary practical experience; and he would then select those who have proved their capacity for a course of higher technical training; and he says that the Admiralty system for training Constructors and Naval Engineers "approximates to this ideal." But the impression remains that the English system, while it does afford opportunities to the more capable men and does turn out some highly educated constructors and naval engineers, pays far too little attention to the training of the great majority of the engineering staff; and this impression is heightened by the very complaints of the engineering staff of non-recognition and relatively lower position and pay throughout their service. The fact of the matter is that England needs to remodel her naval personnel just as we are now endeavoring to do better to fit the men to the material of modern naval warfare. A system of training and relative position on board a warship that has been in use for half-a-century, even with "some modifications," is very likely to need some more radical remodeling, in the light of the rapidity with which matters naval as well as civil now progress; and we are heartily in sympathy with the efforts of the English naval engineers who recognize the need for reform.

In connection with our previous remarks upon the relative social standing of English engineer officers, to which our correspondent calls our attention, we disclaim any intention of drawing distinctions between the two classes of officers that reflect in any way upon the standing of the engineers as individuals. No artificial system of training can make a gentleman, or deprive him of that title where it rightfully belongs to him. But based upon the statement that the English naval engineer passed directly from civil life to the engine room, we had in view the effect of a similar system in the American Navy, which gave rise to a conflict that lasted for a generation. In the beginning of steam engineering, the officer in the engine room was selected for his mechanical experience alone, and the educated line officer, with all his traditions behind him, regarded this engineer as a mechanic and as not up to the social standard demanded of a naval officer. Modern methods of training engineer officers and the vast responsibilities placed upon them by the advance in naval construction have radically changed all that; but the tradition clings to both navies, especially among the younger men, and the only method of wholly eradicating it seems to be the amalgamation of the two branches of the service, as proposed in the American navy.

NOTABLE BRIDGE CONSTRUCTION IN 1898.

The past few years have been notable for the removal of many historic American bridges and the construction in their places of structures of modern type having greater capacity and strength. At Niagara Falls the two famous suspension bridges near the great cataract have given way to modern steel arches, and the remnants of the still older Lewiston & Queenston suspension bridge built in 1851 and partly destroyed by wind in 1864, have been cleared away and a new structure of the same type is now going up on the old site. The great suspension span built across the Ohio River at Cincinnati, O., in 1857, is being strengthened and extensively reconstructed. This structure, like the heavier of the Niagara suspension bridges, was designed by John A. Roebling. At Montreal the Victoria tubular bridge across the St. Lawrence River, designed by Robert Stephenson and considered at the time of its construction one of the great engineering works of the world, has outlived its usefulness and is now being replaced by a modern truss bridge, heavier and stronger, and having more than double the capacity of the older structure. These new bridges, with one exception, belong to the past year's work, and are conspicuous examples of the best American bridge practice.

The year's bridge construction also includes a number of other structures which are quite as notable in different ways. As most of our readers know, a second bridge is now in process of construction between Manhattan Island and Brooklyn. The studies for new bridges to cross both the East and the Hudson rivers have been continued through the year, and have still further increased the knowledge of engineers concerning the possibilities of long spans. In the construction of masonry arches and drawbridges there has been a further development of some of the promising departures of practice which have arisen during the last half dozen years. Alaska has built its first metal bridge as well as its first

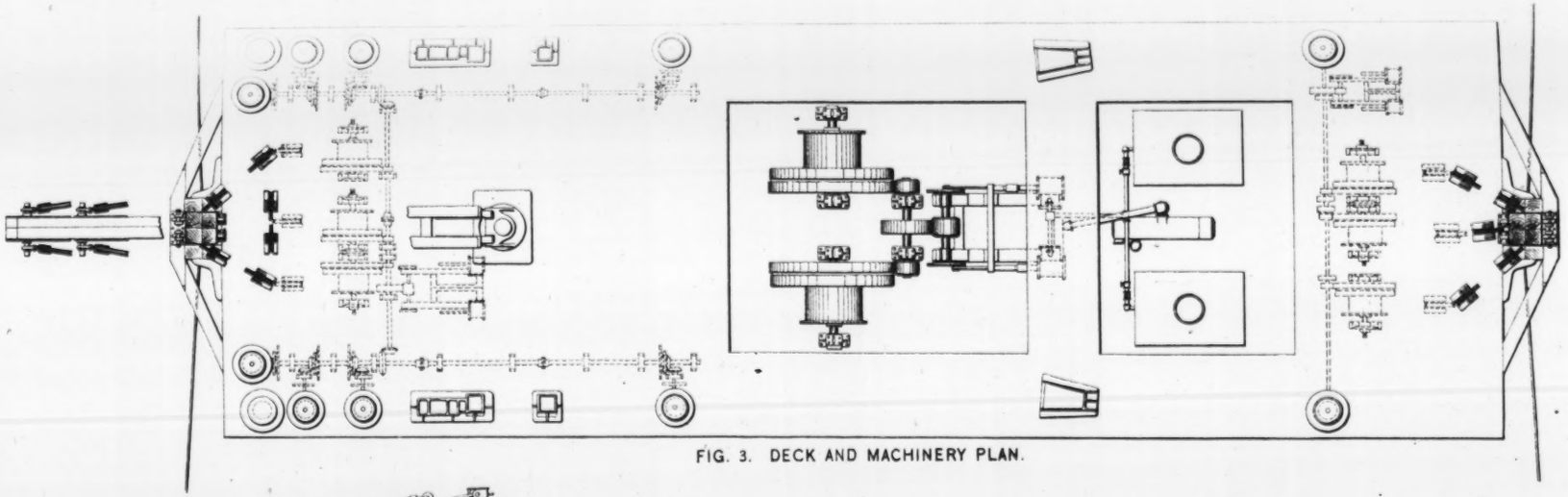


FIG. 3. DECK AND MACHINERY PLAN.

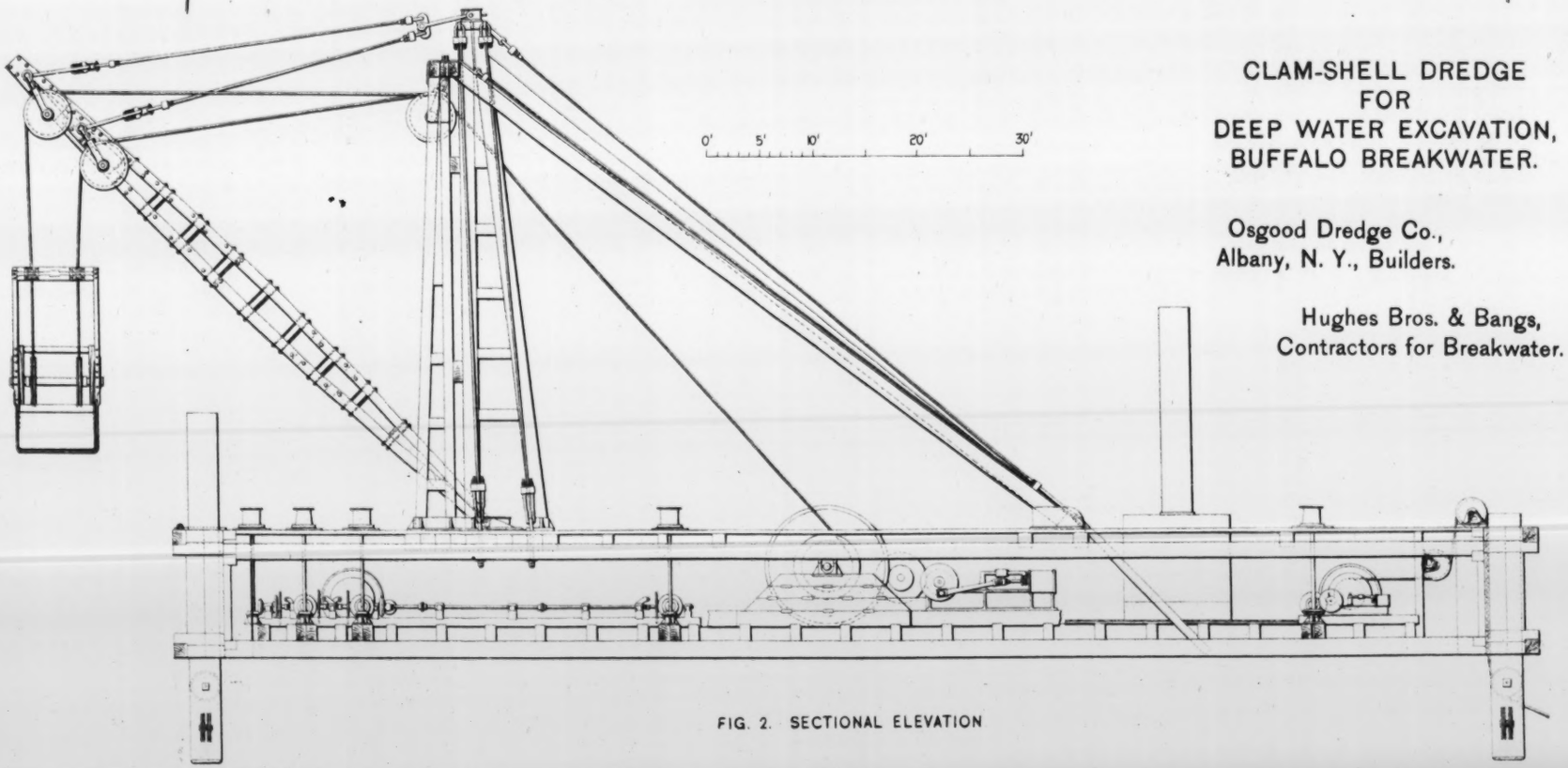


FIG. 2. SECTIONAL ELEVATION

CLAM-SHELL DREDGE FOR DEEP WATER EXCAVATION, BUFFALO BREAKWATER.

Osgood Dredge Co.,
Albany, N. Y., Builders.

Hughes Bros. & Bangs,
Contractors for Breakwater.

CHAS. HART, LITH., 26 VESEY ST., N. Y.

FIG. 4. DIAGRAM SHOWING ARRANGEMENT OF FIXED AND EXPANSION BEARINGS.

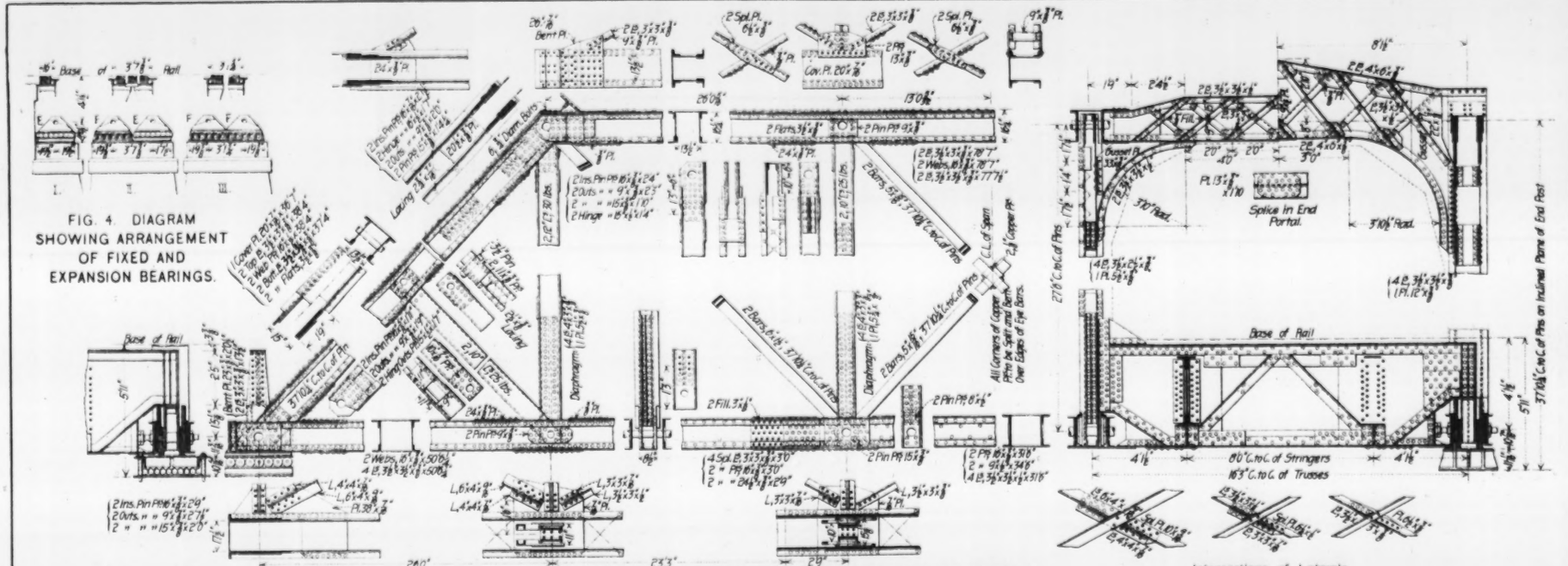


FIG. 1. ELEVATION, PLANS AND SECTIONS OF TRUSS.

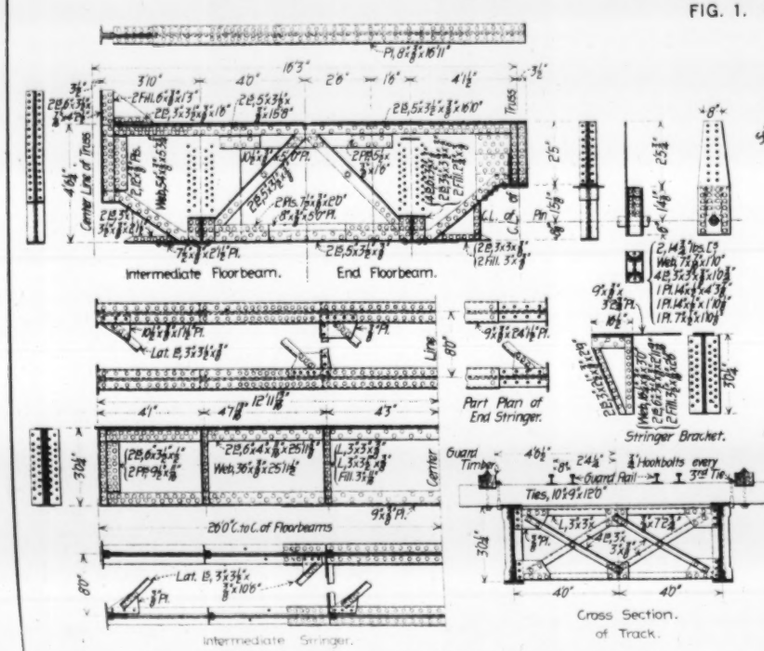


FIG. 3. DETAILS OF FLOOR BEAMS, STRINGERS, AND TRACK.

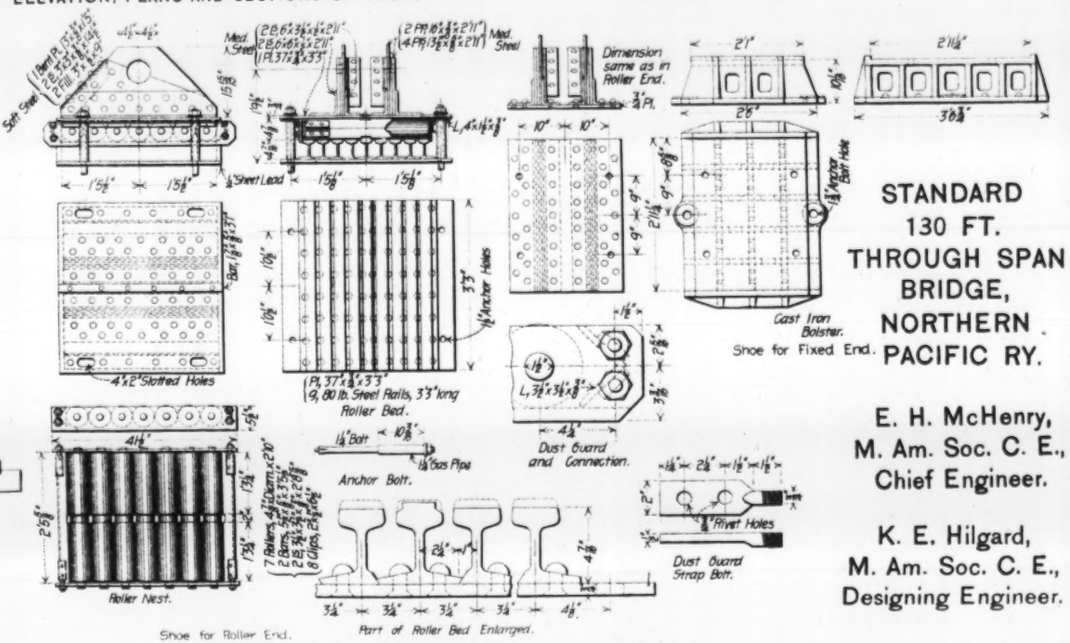


FIG. 2. DETAILS OF FIXED AND EXPANSION BEARINGS.

STANDARD 130 FT. THROUGH SPAN BRIDGE, NORTHERN PACIFIC RY.

E. H. McHenry,
M. Am. Soc. C. E.,
Chief Engineer.

K. E. Hilgard,
M. Am. Soc. C. E.,
Designing Engineer.

railway line this year, and bridge construction of a notabe character has occurred in eastern Russia, China, Japan, Australia and India, as well as in Great Britain and Continental Europe.

In view of these different directions in which the bridge construction of the past year has made progress, it will be of interest to study briefly the characteristics of some of the latest and most typical examples of the work accomplished. The past volumes of this journal will be used as a basis and guide in making this study, and the full descriptions of the various structures given in them from time to time will be referred to for the details which naturally do not find a place in a general summary. No attempt will be made to describe all the new bridges of interest built during the year, nor will the limits of the last twelve months be strictly observed where the discussion can be made clear by reference to instructive older examples of bridge work.

In suspension bridge construction the New East River Bridge crossing the East River at a point about two miles north of the present New York & Brooklyn Bridge, certainly merits first mention. This bridge has the longest span of any suspension bridge ever built or now actually under construction; the distance between towers being 1,600 ft., or 4½ ft. more than that of the Brooklyn Bridge. The similarity of the two bridges in length of span and general type suggests naturally their comparison. Such a comparison can only be along general lines, however, as the plans for the cables and main span of the new bridge have not yet been made public. Briefly stated, the chief points of dissimilarity are: the use of steel towers instead of masonry; the support of the platform for the shore spans entirely independent of the cables; the omission of all inclined stays; and the use of riveted instead of pin connections for the stiffening trusses.

No work has been done upon the superstructure of the New East River Bridge, but the tower foundations are practically completed, and work on the anchorages is well advanced. Pneumatic caissons were used in sinking the tower foundations, and it is interesting to note that one of these caissons reached the depth of 107½ ft. below water, which is exceeded only by the depth of 109 ft. 8½ ins., reached in sinking the caissons for the Eads bridge at St. Louis, Mo. The caisson which reached this great depth was the northernmost of the two for the Brooklyn tower and was 65 × 119 ft. in its lateral dimensions. In excavating the final 5 ft. the men worked two 45-minute shifts in 24 hours and received for this amount of work $3.50. Several cases of "bends" occurred among the workmen but no fatalities resulted. Indeed, a notable feature of the foundation work for the new bridge can rightly be claimed to have been its freedom from serious trouble of any kind considering the large amount of different work which has been rapidly accomplished. Except that they were of a magnitude commemorate with that of the work the plant and appliances used on the work were not more notable than have been employed in other recent pneumatic foundation construction.

Second in importance to the New East River Bridge comes the reconstruction of the Covington & Cincinnati suspension bridge across the Ohio River at Cincinnati. This bridge was completed in 1857 and was, until the construction of the Brooklyn Bridge, the largest and heaviest suspension span in the world. The work of reconstruction is important because of its magnitude, and also because the same methods have been suggested for strengthening the present Brooklyn Bridge. Very briefly summarized the new work comprises the lengthening of the approaches, a pretty complete reconstruction of the platform, and the addition of two new cables. These two cables are 10½ ins. in diameter, made up of 2,226 parallel steel wires, each 0.205 in. in diameter. They are placed parallel to and 6 ft. above the old cables, between the towers, but diverge from the parallel beyond the towers and extend to independent new anchorages further inshore than the anchorages of the old cables. Between towers the suspenders are attached to both cables, the connections being of course in the same vertical line or one above the other. The reconstruction about doubles the capacity of the bridge, and it will cost $650,000. For $2,500,000 it is estimated that the capacity of the Brooklyn Bridge could be doubled by a similar reconstruction.

Before passing from this work it is curious to notice the relative strength of the old 12½-in. iron and the new 10½-in. steel cables. The new cables, despite the fact that they are 2 ins. less in diameter, have an aggregate strength of 24,000,000 lbs., while the combined strength of the two old cables is 8,200,000 lbs. The old cables were each composed of 5,000 parallel wires, each 0.148-in. in diameter. The significance of this brief comparison will be appreciated by engineers without enlarging upon it here.

The new Lewiston & Queenston bridge which has been also mentioned as comprised in the suspension bridge work of the past year is in a measure the reincarnation of the last highway suspension bridge from Niagara Falls to Clifton, Ont., the cables of that structure being employed in the new bridge. Between towers the Lewiston bridge has a span of 1,040 ft., but the length of the platform and stiffening trusses is only 800 ft., the towers being placed somewhat inshore and there being an approach span at each end. At the points where the suspended and approach spans meet, the engineers have employed a rocker bent to sustain and distribute the strains properly, and this is essentially the novel feature of the structure. It may be interesting to recall that when completed this new bridge will be the only suspension span which will cross the Niagara Gorge, and that it is the eighth bridge to be built across this gorge since 1855.

Two of these bridges are the steel arches which now stand on the sites of the highway suspension bridge and the suspension railway bridge near the cataract. These two bridges are undoubtedly among the best examples of steel arch construction in America. Both are two-hinged arches, with curved bottom and horizontal top chords, the railway bridge being of the spandrel braced type and the highway bridge having diagonal bracing. The highway bridge has the longest span of any metal arch in the world, it being 840 ft. between piers. While the railway arch has a shorter span, it is a far heavier structure. Perhaps the most notable features of this arch as compared with others of the same type are: the inclination of the arch ribs toward the center axes of the bridge at the crown; the use of riveted connections throughout with all bracing made up of stiff members, and the arrangement of the end shoes so as to form practically a pin with a diameter of about 9 ft., and with roller friction. The structure has proved notable for its rigidity.

Another arched bridge of the two-hinged type and having stiff bracing with riveted connections was built during the year to cross the Schuylkill River in Fairmount Park, Philadelphia. There were four arch spans in the bridge, each 208 ft. long. In European countries two arch structures which deserve particular mention are the Alexander III. Bridge ,across the Seine, in Paris, and the Muengsten arch over the valley of the Wupper, in Prussia. The first of these bridges is a highway structure, having the unusual width of 131.2 ft., and a span of 352.6 ft., with a rise of only 20.6 ft. This is a three-hinged structure, with a solid web arch rib. Without much question, however, the most notable feature of this bridge was the use of steel caissons of the immense size of 106 × 145.2 ft. for the abutment foundations. These caissons were sunk by the pneumatic process, and so far as we now recall are the largest single caissons of metal ever employed. The Prussian bridge at Muengsten is a parabolic open web arch of 547.6 ft. span. One of the peculiar features of this arch is that its lower panels are built into the steel trestle towers or piers at the ends of the arch, and in fact forms a part of them. A part of the permanent construction of this bridge is three travelers, giving access to all parts of the metalwork, which are designed to be used for making inspection and repairs, and in painting. A smaller arch of 380-ft. span forms a part of the new Kornhaus viaduct near Berne, Switzerland.

In truss bridges the new Victoria bridge, which replaces the Robert Stephenson tubular bridge across the St. Lawrence River, at Montreal, Canada, is perhaps the most remarkable. This bridge will have 24 spans of 254 ft. each, and one of 348 ft., all pin-connected. Nearly 20,000 tons of open hearth steel will be used in the bridge, as compared with 9,000 tons of boiler iron used in the old tube. The proposed Red River railway bridge in China, for which French engineers secured the contract in 1898, as briefly described in the French papers, will have a total length between abutments of 5,838 ft., divided into spans of 246 ft., with one span of 348 ft. The piers will rest on metal caissons which, it is stated, will be sunk to the great depths of 98 ft., by the pneumatic process. Altogether there will be about 5,500 tons of steel in the structure. Another foreign bridge notable for its length is that designed to carry the Central Asian Ry. across the River Amu Daria in Russia. This structure will, it is reported, have a length of three miles, most of which will be viaduct, crossing the flood lands bordering the river banks. Among the other structures belonging to this class, which are now under way, the following are worthy of enumeration: The Gray's Ferry bridge, crossing the Schuylkill River in Philadelphia, with 26 spans, having an aggregate length of 1,650 ft.; the Burnett River bridge, at Bundaberg, Australia, with eight lattice spans, 170 ft. long each; the Charleston bridge at Boston, Mass., having ten 85-ft. plate-girder spans and a 240-ft. swing span; the arch truss viaduct consisting of 25 spans of 65-ft. length each, over the Manhattan valley in New York city.

In drawbridge construction there has been a notable development within a few years in the use of bascule spans. Where the waterways to be crossed are restricted in width and the land bordering their banks is costly there is not much doubt indeed that some form of bascule span is the favorite with engineers at the present time. One notable result of this tendency has been to develop designs for bascule spans of a capacity far greater than it has heretofore been thought advisable to build them. The designs adopted for the railway drawbridge across the Drainage Canal at Chicago were for an eight-track double bascule, providing a clear opening of 120 ft., and a six-track bridge of the same form is being built to carry the tracks of the new terminal station at Boston across the Ft. Pond channel. These are the two most notable bascule spans of the past year. A swing span which deserves notice in passing is that for the new Charlestown Bridge in Boston. This span is 240 ft. long, and has the great width of 100 ft. and a total weight of 1,200 tons, which will be recognized as unusual for a highway bridge of such a short span.

The two really notable developments of the past few years in masonry bridges have been the increasing use of concrete and embedded metal combination structures, and the successful design and construction of articulated or hinged arches in concrete. A number of concrete and metal arches belong to the bridge work of the past year, the largest of which is the Topeka, Kansas, Melan arch bridge, consisting of five 125-ft. spans, two 110-ft. spans and two 97½-ft. spans. As indicating the confidence placed in the suitability of concrete-metal arch construction for long spans it may be noted that two of the three designs for the Connecticut Ave. bridge at Washington, D. C., provided for structures made up partly or wholly of Melan arches. The longest of these projected arches were of 225-ft. spans, but the other spans run 190 ft., 175 ft., 160 ft., 130 ft., 115 ft. and 105 ft. In America the Melan system of concrete metal construction seems to have the preference of engineers, but in Europe, where the first bridges of concrete and metal combined were erected, the Monier and other systems are also extensively used. Another method of employing concrete in connection with metal, of which the past year's work exhibits several examples, is as floor arches sprung between I-beam girders. The highway bridge of 80-ft. span constructed at De Kalb, Ill., is a structure of this type and others have been built in the vicinity of Pittsburg, Pa., and elsewhere.

The most extensive use of concrete bridges in railway construction during the year, or at any time for that matter, has been in building the extension of the West Highland Ry., of Scotland, to the port of Mallaig on the Sound of Sleat. Nearly all of the numerous viaducts on this new line are monolithic concrete arch structures. These are

solid concrete structures, no metal being employed in any form, and the spans are generally of 30 ft. and 50 ft. The longest single span employed is 127 ft. which has a rise of 22½ ft. and a thickness at the crown of 4 ft. This span, we believe, can justly claim the title of the longest in the world of wholly concrete construction. The largest viaduct on the line, however, is one consisting of 21 50-ft. semicircular concrete arches. This structure has a total length of 1,248 ft. and is 100 ft. high at the highest point. Turning from Scotland to England we find another notable use of concrete in the proposed new Vauxhall Bridge across the Thames. This bridge will have a granite facing, but, structurally, it is purely concrete masonry. The total length of the Vauxhall Bridge will be 760 ft., and it will have five arch spans, one 150 ft., two 144 ft., and two 130 ft. long.

The construction of articulated or hinged concrete arches has been confined to continental Europe, and the latest of them to be built was, we believe, constructed in 1896. Two styles of articulation have been chiefly employed, namely, true-hinge joints of metal or stone, and hinge-like joints of sheet lead. Where true hinges have been used they have been placed at the crown and abutments, as in the typical three-hinged metal arch, but sometimes the lead joints have been introduced at the quarter points, as well as at the crown and abutments. As no actual examples of hinged masonry arches come within the bridge work of the past twelve months we shall not enlarge upon them further here. For those who may be interested in following up the subject we may recommend the paper and discussion on "Three-Hinged Masonry Arches," in the Transactions of the American Society of Civil Engineers for July-Dec., 1898. In this paper the various hinged arches already built are briefly described, a theoretical discussion of the strains in such arches is given, and, finally, the general design and calculation of a three-hinged arch of 286-ft. span are worked out.

In closing this brief review of bridge construction in 1898, it will be proper to recall briefly the large list of designs which have been worked out during recent years for bridges of exceptionally long span. It is not likely that many of these bridges will be built very soon, but the study and investigation which their design has necessitated illustrates excellently the confidence with which engineers undertake to-day the design and construction of very long spans. In some instances, indeed, such as the bridging of the Hudson River at New York city, these designs call for spans of unprecedented length and strength. Altogether, five designs have been prepared for suspension spans from 3,100 ft. to 3,310 ft. for Hudson River bridges. The New East River Bridge, as already stated, is to have a suspension span of 1,600 ft. long, and one anyway and perhaps both of the two additional bridges which are proposed across the East River, will have a span of equal length. At Liverpool, England, the mercantile interests are urging the construction of a bridge across the river Mersey having a suspension span of 2,000 ft.

In the design of cantilevers and other forms of truss construction long spans are quite as numerous, but none of them so far proposed equal the 1,740-ft. spans of the Forth Bridge. Of the 13 competitive designs for the proposed St. Lawrence River bridge at Montreal all but two were for cantilever or other special truss forms. The spans proposed ran from 1,200 ft. to 1,312 ft. The proposed bridge across the same stream at Quebec will have a span of 1,440 ft., and a cantilever structure is called for. At New Orleans the bridge proposed across the Mississippi River has a cantilever span of 1,000 ft., and the Detroit River bridge, proposed a couple of years ago, was a 1,300-ft. cantilever structure. In India the proposed bridge across the Hoogly River, to unite Calcutta and Hourah, will have a center span of 1,000 ft. These are at present the longest spans which bear any promise of ultimate construction, and they are quite ample to illustrate the point which we wished to make. For more complete information concerning these and the other bridges enumerated, we refer our readers to the volumes of Engineering News for 1896-7-8.

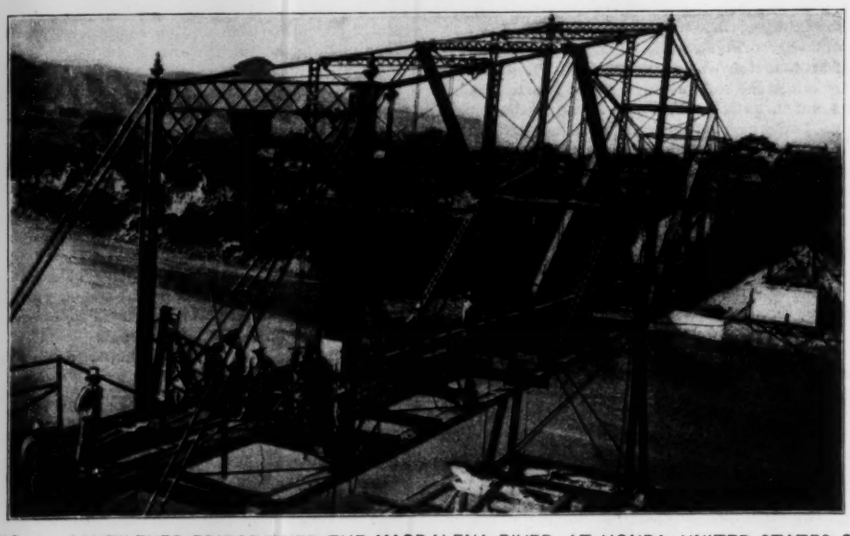


FIG. 1.—CANTILEVER BRIDGE OVER THE MAGDALENA RIVER, AT HONDA, UNITED STATES OF COLOMBIA. VIEW FROM ONE ANCHORAGE AFTER COMPLETING TRUSS CONNECTIONS AND BEFORE LAYING STEEL STRINGERS AND CREOSOTED OAK FLOOR.
Designed and Built by the San Francisco Bridge Co., New York City.

LETTERS TO THE EDITOR.

Comparative Strength of Buckle Plates Laid Convex Face Up and Convex Face Down.

Sir: While general practice in this country is largely to lay buckle plates with convex face up, German practice, at least, seems quite the opposite, and, according to Winkler, a buckle plate with the buckle down is three or four times as strong as it would be with the buckle up, other things being equal. Yours very truly,

James B. French.

24 Fiske Pl., Brooklyn, N. Y., Jan. 28, 1899.

Sir: Buckle plates are often laid convex side down, and the practice is approved by some of the best known bridge engineers. When so laid they are said to develop much greater strength than when laid in the reverse position. If the rivets are properly spaced they should not "tear out," but would develop their full shearing and bearing value. The objection made to laying them this way, that water would collect in the depression, is groundless; first, because they are usually filled with concrete; and secondly, because, when laid convex side up, the valleys around the edges would be more objectionable than the depression in the center. Weep holes are often punched in the center. A large viaduct in Cleveland, built five years ago, by F. C. Osborn, M. Am. Soc. C. E., had the plates laid this way.

Albert W. Buel

New York, Jan. 28, 1899.

Sir: In your issue of Jan. 26 a correspondent (in the "Notes and Queries" column) asks for information as to the comparative strength of buckle plates, when laid with their convex face up and when laid in the reverse position. The question being raised, I would submit as my opinion (1) that buckle plates are used quite often—at least in European countries—with the convex face down; (2) that buckle plates are much stronger in this position than otherwise, for the same reason that makes a thin cylinder stronger against an inside than against an outside pressure of same size, although the theoretical stresses are the same in both cases; (3) that I do not see why the hanging position should induce any danger of the rivets or bolts being torn out, which could not easily be prevented by using some extra rivets at the joints, to allow for the vertical rivet stresses, and by allowing sufficient metal outside of the holes to resist the horizontal forces, which are the same in both cases.

Yours truly, F. Sodemann.

160 Fifth Ave., New York, N. Y., Jan. 27, 1899.

The Failure of a Large Gas Holder in New York City.

Sir: I was present at the investigation into the cause of failure to the large gas tank at 21st St. and Avenue A., belonging to the Consolidated Gas Co., of New York city*, and would like to bring up a few points which were not touched upon as thoroughly as they might have been, and which have since suggested themselves as being a most important factor in the solution of the mystery and cause of failure.

It was proved at the coroner's inquest beyond doubt or question that the tank was sufficiently strong to withstand all pressure brought upon it, and was correct and safe in its design in every particular. The foundations were good, and the material used of the best, the strains not at all excessive. In other words, without going into the engineering details and calculations, which were thoroughly gone over at the inquest, it was proved beyond the shadow of a doubt that the tank was good in design, and that if we were going to build one to-morrow it would be unnecessary to change the plans or specifications.

A perfect structure from an engineering standpoint, designed to withstand more than four times the strain that will ever come upon it, built of good material, does not fall down by itself. There must be a definite cause of failure; an external or foreign force of some kind must be exerted upon it to cause collapse. An explosive force is the only one that acts instantly, and might easily be the cause of such a work, as I will attempt to show.

It was testified at the inquest that the holder was empty of gas, and even if it had been full, and an explosion had occurred, it would have blown the top off the holder, which did not occur, and the whole character of the wreck would have been quite different. A dynamite bomb placed in the water at the side of the tank, or against it outside, would undoubtedly have caused the disaster. But there was not the slightest evidence to prove that anything of the kind took place. There was no trouble among the workmen, or any clew whatever of a criminal nature.

At the northeast corner of the tank was a large cast-iron 30-in. gas main. It was about on a level with the second course of side plating, or in the neighborhood of 10 ft. below the level of the street. It was one of the main gas connections with the tank, and ran down under it, coming up through the bottom. The 30-in. gas main was completely shattered by whatever happened, and to my own knowledge a piece of 30-in. gas main was found on top of a four-story house near by. It seems highly improbable that heavy pieces of 30-in. gas main should go sailing up and land on four-story buildings without a definite cause. The tank failure and the consequent fearful rush of water would not send fragments of gas main sailing up like skyrockets. In short, why could not an explosion in the 30-in. gas main within a foot or so of the side of the tank have caused the whole disaster? A curious coincidence also suggests itself, and that is that the wreck was the greatest at this point; and it is admitted by all that whatever occurred, occurred first at this point. No light whatever was given at the inquest as to the condition of this large 30-in. gas main before the accident, its connections, etc.

One reads of many accidents caused by gas explosions in subway manholes, and accounts are not rare of the occasional excursion into midair of iron manhole covers. It therefore seems to be within the range of probability that an explosion of gas might occur at or near the 30-in. main, especially as the connections with the tank were not complete and leakage was more likely to occur. If an explosion of gas did occur outside the tank at a point where the 30-in. gas main was located, it would be sufficient to account for the failure of the tank, and the tremendous volume of water which escaped would complete the wreck and general devastation. That fragment of gas main found on top of the four-story building may know more about it than I do. Yours truly,

Allan A. Robbins,

Yale Scientific School, Class of 1893; First Lieut. First Regt. U. S. V. Engineers (resigned).

9 E. 36th St., New York City, Jan. 26, 1899.

*Eng. News, Dec. 15 and Dec 22, 1898.

A Central American Mule Bridge.

Sir: In your issue of Dec. 29 there appeared the following personal:

Mr. Geo. W. Jones, who has just completed a large bridge over the Magdalena River, in the United States of Colombia, arrived in New York, Dec. 19, on the steamer "Altai." The bridge has taken seven years to build on account of the swiftness of the river.

As the above-mentioned bridge was designed by the writer and built by the San Francisco Bridge Co., for whom Mr. Jones acted as erecting foreman, and as the bridge was erected in seven months instead of seven years, we hope you will permit us to correct the above misleading paragraph.

Aside from this correction, however, the structure mentioned possesses a somewhat interesting and amusing history, which may be of service to others contemplating the building of engineering structures in Spanish America. One of the richest men in the United States of Colombia is Mr. Bernardo Navarro, merchant, of Honda, on the Magdalena River near the head of navigation, well toward the interior of the state. The river has steep banks at this town and a swift current, ranging from four to eight miles per hour. All travel and traffic has heretofore crossed the river by flatboat ferry and been compelled to climb down one steep bank and up the other. Three years ago, Mr. Navarro engaged an intelligent American engineer in his neighborhood to negotiate in this country for a high-level bridge about 560 ft. in total length to span the river at Honda. This company then made and tendered on the cantilever design, which has just been erected, and then for more than two years heard nothing from Navarro or his engineer as to the disposition of the contract. About a year ago the bridge company unexpectedly received a letter from Navarro stating that the American engineer had died before accepting our proposition and that after two years delay a search through the correspondence of the deceased had brought to light our proposition as the best one received, and we were asked whether we would be willing to adhere to the original terms proposed. We accepted the situation with some misgiving as to the substitution of a Spanish engineer for the former American, and the result showed that our misgiving was well founded. A supposed accurate and final set of span measurements and profiles were sent to us by the Spaniard, and we built the bridge in strict accordance therewith allowing a few inches extra length for the key pieces at the meeting point of the center span.

When our men arrived on the ground to erect the structure they discovered that the center span had a trifling error of 13 ft. in a distance of 360 ft. Fortunately the span measurement was this amount too short and could be remedied in the field by cutting down a couple of the middle panels which fortunately also contained no eye-bars. The Spanish engineer on being confronted with the slight error begged and implored that the terrible news be withheld from his employer in order that his "honor as an engineer" might be preserved. So well did diplomacy deal with the situation that by the time the middle panels were reached in erection, Mr. Navarro was explaining to his many friends that he had seen too much of bringing bridges into the country that proved too short for their location, and he had determined to have his structure plenty long enough, so that no harm was done. All the same he paid a bill of extras for the work of correcting the error.

The Spanish engineer further got into trouble over the foundations. The main piers were originally of masonry reaching to the superstructure. At our suggestion steel piers were adopted above high-water mark, and we explained to the Spanish engineer that the remaining masonry should be lengthened on account of the considerable batter of the steel pier posts. The Spaniard, however, put all the lengthening into the width of the masonry instead of the length of it, and we did not discover this fact until the masonry was completed and the pier material in the shop, hence the pier posts had to be straightened up to a very little batter and provision made for tension anchorage on the windward side. This somewhat interferes with the appearance of the structure, but is a Spanish feature of the problem and not an American.

The capacity of the structure would make Mr. Theodore Cooper turn green. Cooper's specifications for highway bridges state that "no span shall be proportioned for a less live load than 1,200 lbs. per lin. ft." We accordingly designed the Honda bridge for 500 lbs. per lin. ft., but did Mr. Cooper the compliment of using his unit strains.

We may be pardoned by the engineering profession, however, if we state that there are no wagon roads in the country, and that a string of pack mules will be the heaviest loading on a floor, which in spite of 17 ft. width c. to c. of trusses, has been kept down to 12 ft. from fence to fence, in order physically to prevent a greater application of live load than the amount assumed. We invite the verification of the engineering profession on our assumpton that mules loaded with packs on a 12-ft. roadway can not produce a heavier loading on said roadway than 500 lbs. per lin. ft. As wind pressures are harder to control than mule pressures, we took no such liberties with Mr. Cooper on the lateral bracing as we did with the live loading.

In case your readers should take any interest in the outline and sections of the structure, we send you a photograph, Fig. 1, showing the bridge after connections had all been made but before the steel joists and wooden planking had been placed, and we also submit an outline diagram of the half span giving dimensions and sections. Many of the sections are heavier than the figures call for, for practical reasons. The structure was figured for an average dead load of 750 lbs. per foot of bridge, and a live load of 500 lbs. The dead load, however, was apportioned as the increased weight of the structure toward the main piers would require, as usual in cantilever design. The weight of a panel load, due to the truss only, being four times as much near the main piers as at the middle of the center span.

The erection was done, without steam power hoisting, by means of an interior overhang traveler of simple construction; and four white men, including our erecting foreman, did practically all the immediate handling of the material in the air.

The only feature of technical interest in the detail of the structure was the simple device for controlling the level of the chords at the meeting points of the center span. Referring to the diagram of the truss the false member (after erection) K-L was hinged in the middle and as first put in place was knuckled downward at the middle by screwing up on the turnbuckle rods KK-12. This caused the meeting points 0 and 16 to come considerably higher than their proper position. By slacking away on the extra long turnbuckles in rods KK-12 the meeting ends of the centre span could be lowered to exactly their proper contact point. It would have been in vain to attempt to lift them again, or at all, by screwing up on said turnbuckles, but there was no trouble whatever about the lowering. After the complicated arrangements of wedges on roller bearings usually adopted for cantilever erection, we claim an advance in the good engineering of simplicity. The lateral position of the meeting points could be controlled between wide limits by adjusting the lateral rods from the main piers outward.

Our client, Mr. Navarro, was delighted with the bridge, of course, but seemed to take much deeper interest in the design of the gates and name-plate which appear in the photograph, than in the engineering aspects of the structure. We had supposed that the gates were to keep out mules, but it seems he wanted them man-proof also, so we shall have to send him a lot of cat-proof-back-yard-fence-trimming. His name-plate was a great disappointment to him, being far too small to suit his taste. The motto as dictated by him and appearing in perforated letters would read in English as follows:

"INDUSTRY, ORDER AND ECONOMY.
"BERNARDO NAVARRO.
"1898."

It occurred to us that perhaps the word "honesty" might have been quite as important as "order," but then, perhaps Mr. Navarro was only announcing the principles which had governed the accumulation of his fortune.

We have promised to send him a name-plate several times as large, with letters that can be read across the river, if he orders another bridge of us.

Yours truly,
San Francisco Bridge Co.,
By H. S. Wood, Engineer.

New York, N. Y., June 6, 1899.

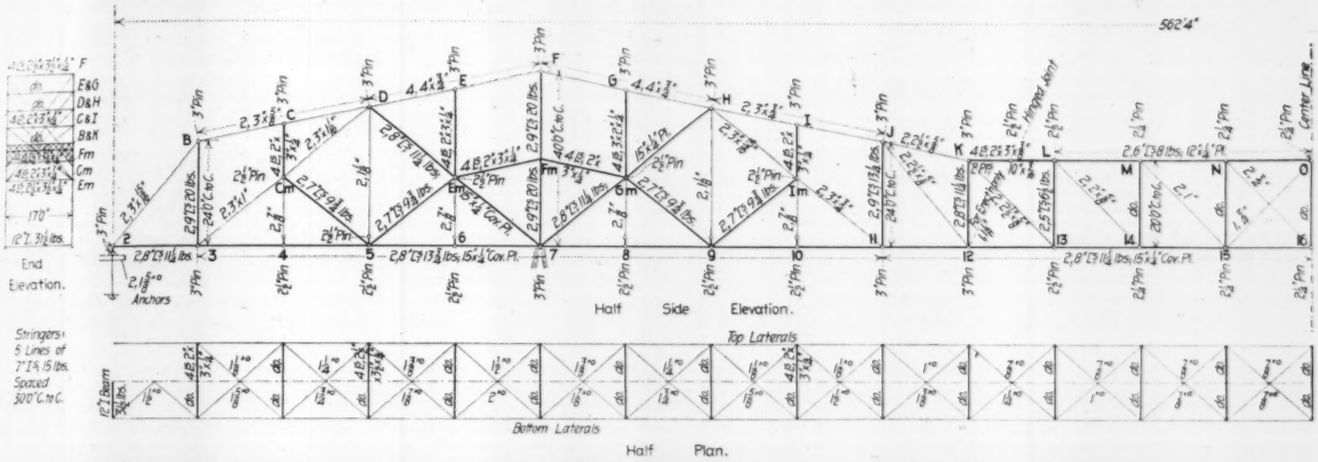


FIG. 2.—DIAGRAM ELEVATION AND PLAN SHOWING FRAMING AND COMPOSITION OF HONDA CANTILEVER BRIDGE.

Engineering Notes in Southern California.

Sir: The city of Los Angeles occupies a territory of 40.75 square miles, since University and other outlying portions have been taken into the corporation, and it is estimated that the 200,000 mark in population will be reached in 1905. The business district is extending to the southwest from Spring and First Streets, there having been numerous handsome business blocks erected recently. The Stimson building, on Third and Spring Streets, the Wilcox building and the Douglas building, also on Spring St., and the Bradbury, Laughlin and Byrne buildings, on Broadway, being as handsome brick and stone structures as are to be found in the East.

The present city engineer, Mr. F. H. Olmsted, reports much new work which the city will do in 1899. There are at present 182.9 miles of graded streets, of which 14.33 miles were graded in 1898. The amount of paved streets, nearly all asphalt, is 17.75 miles, 1.1 miles being laid last year. There are at the present time 140.31 miles of sewers, of which 7.0 miles were built in 1898.

The outfall sewer to the ocean, which was constructed a few years ago (Eng. News, Feb. 28, 1895), is reported to be in bad shape at a number of places and to need repairs. It did not provide for the Pico Heights and University districts, which have been added to the city since it was built, and it will be necessary either to provide a pumping plant, build a sewer part way to the ocean to intercept the outfall, or else to build one entirely to the ocean.

The city is seeking to acquire the plant of the water company, and to this end an estimate or valuation was made by the water company, and one by the then city engineer, Mr. J. H. Dockweiler. As these were so widely at variance, a board of consulting engineers was appointed to make a valuation for the city; they are Mr. J. D. Schuyler, M. Am. Soc. C. E., Mr. A. L. Adams, Mr. A. H. Koebig and Mr. J. B. Lippincott. Their valuation is $826,940, which includes 10% for engineering supervision and contingencies and 6% as a contractor's profit and interest on capital during construction. The water company's valuation is $2,500,266, and that of Mr. Harry Hawgood, their consulting engineer, $2,348,648. The work of harmonizing these estimates has been referred to a board of arbitrators, but a lengthy hearing will result, with a probability of litigation.

The contract has just been awarded for the construction of four bridges, which are the largest the city has undertaken for some years. They are all to be combination structures, with compression members, floor beams and joists of Washington fir. The compression formula used being $650 - 25\,l^2 \div d^2$, l being the length of the member in feet and d the least dimension in inches. The tension members are to be of medium steel, the unit of stress on main bars to be 12,500 lbs. per sq. in., on hangers 9,000 lbs., and on laterals 18,000 lbs. On the wooden joists is to be laid 3-in. fir plank, and this is to be covered with

sheet asphalt, 1½ ins. thick at the sides and 3 ins. thick at the center. The bridge over the Hollenbeck Park is to be an arch of 166 ft. span and only 15 ft. rise.

Directly north and west of the business portion of the city, communication is interrupted by high hills, which are quite abrupt on both sides. Contracts have been awarded to tunnel these hills, on Broadway, from California St. to Bellevue Ave., and on Third St., from Hill St. to Flower St. The Broadway tunnel will have a length of 720 ft., a grade of 6%, while the 40 ft. of width will be divided into a macadam roadway of 32 ft. and a concrete sidewalk of 8 ft. The cross section will be nearly semicircular, with a radius of 20 ft., the arch being of brick, six rings thick, laid in cement. The Third St. tunnel will be 1,064 ft. in length, the grade 0.566%, and the 32 ft. of width divided into 6 ft. of cement sidewalk and 26 ft. of asphalt roadway. The upper part of the arch is semicircular, the radius being 16 ft., with the center 4 ft. above the horizontal from the outside of the roadway. The arch ring is six bricks thick and laid in cement. The contract for the former was awarded to Edward & Beyrle, at $66,900, and on the latter to C. L. Powell, at $88,449. These tunnels will open up residence tracts close in to business, which have been accessible only by taking the cars for quite a distance around.

The street railways of Los Angeles have been greatly extended, the single track mileage of the Los Angeles Ry. Co., which is controlled by the Southern Pacific Co., being 84.36 miles. This company was formed by the consolidation of eight separate lines in 1893, and in Oct., 1898, the Main St. line, with a length of ten miles, and the Main, Fifth and San Pedro Streets line, 4.25 miles long, were absorbed.

The power station is on Central Ave., and is equipped with Stirling boilers using crude oil fuel, which is obtained at less than $1.00 per barrel, and with engines of various makes, Ball, Allis, Golden State and Risdon, and both General Electric and Westinghouse dynamos. They operate 134 motor cars and 55 trailers, most of the motor cars being with outside seats at each end. The rails are of T-section; 45 lbs. was the old weight, but all the new rails are 60-lb. New track is being laid on Seventh St. and on Figueroa St., the ties being of redwood. Where the tracks of the old cable line are run over, they are gradually being replaced. In removing the slot rails and yokes, the concrete in which they were set, and which is very hard, requires to be broken up, and to accomplish this a rig similar to a low pile-driver derrick is used. This is mounted on trucks or rollers, is swiveled on its carriage, and the cutter, which is like a huge cold chisel set in a pile-hammer, is operated by means of an electric motor. It is dropped on the concrete immediately back of a yoke, wedging it forward and cracking out a section of what has practically become stone.

The Temple St. cable line, having 4.75 miles of track, and the Main and Fifth St. electric line, are the only separate lines, excepting those of the Los Angeles Traction Co., which is a serious competitor of the other large company. They had 18 miles of track before the recent completion of their Boyle Heights line. The rails on their tracks are 60-lb. and 70-lb. "Shanghai." The Pasadena & Pacific suburban line, with tracks from the city to Pasadena and to the ocean at Santa Monica, has 45 miles of track, which is laid with 40-lb. and 50-lb. T-rail. The control of this line was acquired the first of the year by the Southern Pacific Co.

There are electric suburban lines projected to Whittier and other points, some of which will likely be built in the near future. The Mount Lowe inclined railway, which climbs to the summit of the Sierra Madre range, has not been a paying property as a separate institution, and after being through various troubles, including a receivership, it is rumored that it too will be controlled by another railway.

At the time of the writer's first acquaintance with Southern California, nearly ten years ago, the great cost of coal made the question of power supply a very serious one, but at that time there was no appreciation of the great possibilities of water power from mountain streams for the generation of electricity. A few years later the discovery of oil in large quantities within the corporate limits of Los Angeles, provided a supply of cheap fuel for many uses. But now the building of several large electric power plants will insure a supply of electricity generated by water power from the mountain streams. The first of these was the San Gabriel Electric Co., using water from the San Gabriel River, with a power plant at Azusa, and which furnishes part of the current for lighting the city of Los Angeles. The most extensive plant is that of the Southern California Power Co., at Redlands, which gets its water for power 14 miles up the Santa Ana canyon, near the junction of Bear Creek and Santa Ana River, where a temporary diversion plant has been built—it being the intention to construct at some time a large steel dam for the impounding of water. The flumes for carrying the water to the power house are permanently built, and the necessary tunnels are arched and floored with cement. All the construction work was done under Mr. Edw. M. Boggs, chief engineer. The water reaches the power house, which is constructed of cement, under a head of 728 ft., and operates four large Pelton water wheels which drive the dynamos. The current will be carried 80 miles by overhead wires under high tension to Los Angeles, where transformers will be used to reduce the voltage before it reaches the consumer. It is believed that the street railway systems will all be operated with current from this source, one company being under contract to use it at the present time.

The small amount of rainfall on the southern coast for the three past years has directed attention anew to the subject of creating larger irrigation reservoirs in the mountains by building the present dams higher and by constructing new ones. Before the recent rains the users of water from the famous Bear Valley reservoir were only allowed one-third of the usual supply. The Bear Valley Irrigation Co., which was capitalized at $4,000,000, has been in the hands of a receiver for several years, and should it be reorganized, as is now proposed, the new Bear Valley dam will likely be built to the height of 120 ft., as originally proposed, instead of 80 ft., as it now is, and will retain enough water to last over three dry years. There is an irrigation system proposed to utilize the waters of Lytle Creek, but it savors so much of an "Arabian Nights" scheme as to be merely worth mention. It has been stated that the dams are to be four times as high as at Bear Valley, and other things nearly as absurd are told of the plans.

The oil fields of Southern California have been extensively developed during the past three years. When the first oil in considerable quantity was obtained from the wells in this city the price of the crude oil was cut down to as low as 50 cts. per barrel, but associations were soon formed, with the effect of bringing up the price to a much higher figure. The oil producers' trustees paid to members the net sum of 77.58 cts. per barrel for the November sales, which were 17,260 barrels, which was on the basis of 86.19 cts. at the wells. The net price paid for October was 82.06 cts. The production of the city field is about 2,300 to 2,400 barrels per day, the wells being scattered over a large area which adjoins the Westlake Park residence district. An ordinance was passed some time ago which prohibits the drilling of a well nearer than 1,600 ft. to any park, and was framed to protect residence property from encroachment, but as it is the oil is carried in the gutters during heavy rains to miles away, the curbstones being coated with it on Figueroa St. as far out as 30th St.

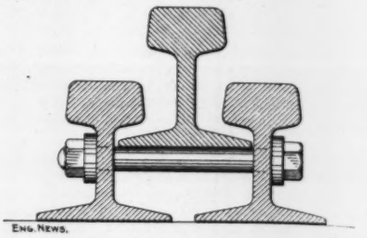
The finest grade of light oil so far reported is that near Fullerton, Orange Co., from wells of about 300 ft. depth. Some of the wells in this county have made quite a showing of gas, and should the flow prove permanent a big development of the gas field will be made. The Santa Barbara oil field is along the coast seven miles south of the town. The most extensive work is being done by the Alaska Steam Whaling Co., which has recently completed a well to a depth of 2,000 ft., and is having several others drilled.

There is no move being made by the Santa Fe Ry. for a line from Mojave Junction north to connect with the recently acquired San Joaquin Valley road, and it is believed here that they will use the tracks of the Southern Pacific Co. from Mojave to Bakersfield. The Santa Fe Limited, which leaves this city Monday, Wednesday and Friday of each week, makes the run to Chicago in 2⅝ days, the trains from the East arriving here on the same days. Such service makes it possible to have business letters reach Chicago and a reply come back in seven days. The San Diego line of the company will be a more profitable piece of property in connection with the Asiatic steamship line of the California & Oriental Steamship Co., which is one of the very apparent results of the new policy of expansion. The first steamer—the "Belgian King"—is due to arrive this week with freight from Manila, China and Japan. The cargo consists of rice, tea, silks, matting and oriental goods, and will require about 250 cars for shipping East. New sidings have been constructed at San Diego, the wharf repaired and a new warehouse constructed. It is reported that nearly 100 cars are in the yards there from the East with goods for the out trip, and about 200 cars more of goods between here and Kansas City. The line has three steamships at present, and if freight continues to offer, more will be added. Negotiations are in progress for a line down the coast of Lower California and Mexico, to be operated in connection with the Transpacific line.

The Southern Pacific Co. has two fast trains over the "Sunset Route" to New Orleans each week, and has recently put on a daily train each way between here and San Francisco, known as the "Owl Train," which makes the run in less than 15 hours—a distance of 485 miles. The shortest time of the regular trains was 22 hours. The completion of the coast line of this company, which has been so long delayed, seems now to be assured, as men are actually on the ground to recommence work.

During the rains here a very large amount of water has to be carried by the gutters underneath the railway tracks, and an arrangement used by the Southern Pacific Ry. to accomplish this is to form spans of rails 5 ft. in length, as shown in the sketch. A piece of T-rail is placed on each side of the flange of the track rail and bolted through every 18 ins., with bolts passing directly under the track rail. These side rails extend over the bearing at the ends of the span, resting on plate iron. In some places there are three consecutive spans.

A jubilee is soon to be held to commemorate the commencement of work on the breakwater at San Pedro, the appropriation for which was secured after a long congressional fight. The rock for the breakwater will be brought from San Clemente Island, about 60 miles south



Method of Carrying Rails Across Drainage Openings, Southern Pacific Ry.

of San Pedro and beyond Santa Catalina Island. Tunnels of quite large size have been driven into the rock and the blasts will be so arranged that the fragments of stone will be of large size. The contractors' plant is largely completed and the material for the remainder arriving. The stone will be loaded in barges, which will be self-dumping, and towed across by tug boats. It is stated that compressed air will be used to operate the plant.

The harbor is reached from Los Angeles by two railways, the Southern Pacific and the Los Angeles Terminal, which has a system of 51 miles. The fact of it resisting "absorption" so long is evidence that some trunk line—possibly the Union Pacific, as is rumored—is back of it. The much-talked-of Salt Lake-Los Angeles road is again on the carpet as a result of persistent reports of surveying parties along the route. The long-distance telephone lines have been extended along the coast from San Diego to Seattle and well into the interior, and this is one of the numerous up-to-date features which show the advanced state of the Pacific coast.

The Nicaragua Canal is the great public question out here, and committees are to be found everywhere working to further its building by the process of agitation and by collecting money to keep workers at Washington. One would be as much out of place here who did not favor its construction of a "Gold Bug" was in Colorado during the last Presidential campaign. C. E. F.

Los Angeles, Cal., Jan 20, 1899.

A TEST FOR ELECTROLYSIS OF THE JERSEY CITY WATER CONDUITS.

The water supply of Jersey City is carried across the salt marsh known as the Hackensack meadows in three cast-iron mains, two of which are 36 ins. in diameter and one 20 ins. in diameter. On the western side of this marsh the mains run for some distance under a highway known as Belleville Avenue, and for a distance of 2,000 ft. on this avenue the tracks of the Union Traction Co., an electric trolley railway, are laid directly above these pipes. In order to determine whether the return current from this railway was being carried to these pipes, Mr. C. A. Van Keuren, Chief Engineer of the Board of Street and Water Commissioners of Jersey City, recently had tests made by Mr. A. A. Knudson, Electrical Engineer, of 34 Nassau St., New York city. Through Mr. Van Keuren's courtesy we have been favored with a copy of Mr. Knudson's report, dated Jan. 18, 1899. Briefly stated, Mr. Knudson found that where the railway tracks were laid above the pipes on Belleville Avenue, current was flowing from the rails to the pipes, the difference of potential between the rails and the pipes being 2½ to 15 volts. The peculiar course which the current took in order to return to the power house by the path of least resistance is indicated in the accompanying sketch, and more fully in the following extracts from Mr. Knudson's report, in which the method of making the test is also described:

As there are no fire hydrants on Belleville Ave., excavations were necessary to make the desired tests. Two were made—one at the intersection of Belleville and Kearney Aves., near the reservoir, and the other at Elm St. The distance between the two excavations was about 2,000 ft., for which distance the tracks are just above the pipes. A test was also made at a gate on pipe No. 1, located about 300 ft. from the Elm St. corner. After the mains had been uncovered and electrical connections made, voltmeter readings were taken to ascertain the difference of potential between the rails and pipes. For convenience of reference these data are recorded in the following table:

Records of Electrolysis Tests made on the Jersey City Water Mains.

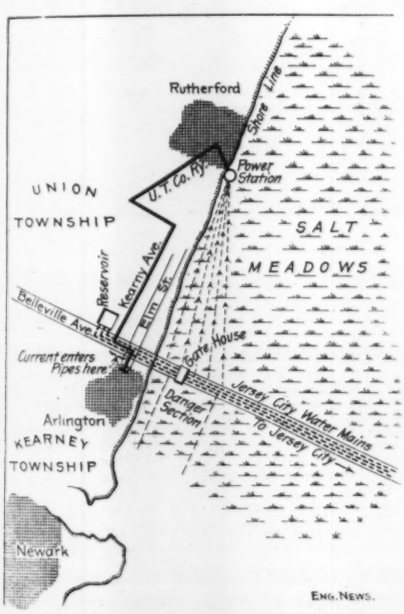
Jan. 5, 1899.	Time: 1 to 3 p.m.	Weather, mild.	
Mains: No.	1*	2	3
Distance from nearest rail, ft.	2½	4½	8½
Diameter of main, ins.	36	36	20
Year when laid	1873	1862	1853
Maximum difference of potential volts (rails positive to mains):			
At Kearney Ave.	5	10	10.2
At Elm St.	2.5	2	4.1
At Elm St. (second test)†	..	..	15
At gate near Elm St.	6	..	..

*Cement covered.
†Second test made Jan. 10, at 12:30 p. m.

The table shows that currents of electricity are passing from the rails into the mains at a voltage much too high to consider them free from the destructive action of electrolysis. The range of maximum voltage is from 5 to 10.2 volts at Kearney Ave., and from 2 to 15 volts at Elm St., this latter high reading being discovered on a second test on pipe No. 3. The rails, however, in all of these tests were positive to the mains; consequently no damage is anticipated from electrolysis to the pipes in this street, and no signs of it were found at the excavations. The rails at both openings, however, showed evidence of electrolysis to a marked degree.

It will be understood that the point where damage to gas and water mains is caused by electrolysis is where the current leaves the pipe, or, in other words, where the pipe tests positive to the rail or some other metal.

In former experience it has been found that when a stray current passes from the rails of the road to water pipes it is very apt to find an exit at some other locality in the system, in seeking another path of easy return to the generator. From a careful study of maps which show geographically the line of the Union Traction Co., the location of their power station and the route of the city water mains, the conclusion is reached that the most probable point of exit would be where the water mains cross the salt meadows on their way to Jersey City, for the following reasons:



Map Showing the Location of the Jersey City Water Mains on the Westerly Side of the Hackensack Meadows, and the Power Station and Tracks of the Union Traction Co.

1. The power station of this road is located at Rutherford, on the border of the salt meadows; 2, the distance in a straight line from the water mains, which the current would take at a point near the shore of this station, is shorter by about two miles than the route of the railway over the various roads through which it runs; 3, the salt water and mud of the marsh in which these mains are partly submerged offer a good conductor for the current to pass through them in a direct line to the aforesaid power station.

Voltmeter tests were accordingly made at a point known as the Gate House, about one-half mile from the shore proper, on Jan. 10, between 10 a. m. and noon. To obtain a suitable ground a steel bar was driven through ice and water and well into the mud of the marsh; to its upper end a wire was connected which was attached to the voltmeter. Electrical contact was then made to each pipe without difficulty, and the voltmeter readings taken. The two outside mains, Nos. 1 and 3, were found positive to the steel bar with a difference of potential of ⅛ volt in both cases, while the middle pipe, No. 2, tested 1 volt negative to the ground bar. The outside mains, 1 and 3, were neutral to each other.

Tests between the mains show that both 1 and 3 are positive to No. 2 with 1 1-5 and 1 1-6 volts, respectively; showing the current to be leaving the two outside mains and passing into the center main.

These tests show a compartively low voltage from the outside pipe to the ground, and under ordinary conditions no particular danger from electrolysis would be feared. In this instance, however, the salt water in which the mains lie is an electrolyte which materially assists the corrosive action of the current. Again, the case is more serious under these conditions when the higher voltage of 1 1-5 is considered, which is found to be passing between the mains. The brick and cement covering on pipe No. 1 would offer little, if any, protection against electrolysis under these conditions. From the tests that were made on the meadows, therefore, the indications are that much of the current which passes into the mains on Belleville Ave. flows along and comes out on the meadows, not at one point, but distributed for some distance along the pipe line, probably for half a mile, more or less, as shown by dotted lines in Fig. 1.

Taking all things into consideration, the passing out of the current on the meadows is a condition which, if allowed to continue, will, in my opinion, seriously shorten the life of these very important water mains.

I do not think that this escape of the current is due to imperfect construction of the electric railway, as, generally speaking, the road is much better built than the average trolley road operating through and between small towns. It is provided with an insulated return conductor throughout its entire length, which many electric roads do not have. I have also seen the type of bond used for electrically connecting the ends of the rails, and they seem to be as good as any of their kind on the market, two being used, I am told, for each rail.

The most effectual method for eliminating this current escape to the mains would be a removal of the rails from that portion of the street in which the mains are located. As this, however, may be impracticable, I would suggest that the company put in more frequent tap connections from the return wire to the rails (these are at present 1,000 ft. apart), and that it examine the rail bonds, as well as cross bonds, and renew all that may be found imperfect. When this is done further tests should be made at the "danger section" on the meadows to determine if the danger from electrolysis has been removed.

The instrument used in making these tests was a standard Weston high and low-reading voltmeter, which was standardized at the Weston factory, Newark, just previous to the test.

ANNUAL MEETING OF THE NATIONAL ASSOCIATION OF MANUFACTURERS.

The fourth annual meeting of this association was held at Cincinnati, Ohio, Jan. 24 to 26.

The convention was opened by welcoming addresses by Governor Asa S. Bushnell, of Ohio, and Col. Gustav Tafel, Mayor of Cincinnati. President Theodore C. Search replied briefly, after which committees for the ensuing year were appointed and the annual report of the President was read. We reprint the following extracts from this report:

Within the brief span of a single year our nation has been thrust suddenly into war and, as the result thereof, has been called upon to face problems involving entirely new elements in our political organism. Almost without warning, we find ourselves in possession of colonies in the West Indies, in the middle of the Pacific and in the Far East, with about 12½ millions of people whose government rests in our hands—for the time being at least. Our war with Spain is at an end, the wrongs of an oppressed people have been righted, but our task, instead of being completed, is only just begun.

Under normal conditions Cuba has purchased from the United States about $20,000,000 worth of merchandise in a single year, while our imports of Cuban products have been as high as $80,000,000 in a year. During the disturbed conditions of recent years our exports with Cuba have fallen to a little more than $7,000,000 and our imports to about $18,000,000 a year. With the advantage of a preferential Cuban tariff Spain has been able to control an abnormally large share of the trade of the island, selling to the people of Cuba as high as $28,000,000 worth in a single year, but never buying of Cuban products more than one-third of that amount. The quick recuperation from the terrible disasters of recent years is but little short of miraculous. Prosperity is now making its appearance where ruin and desolation have long held sway. Capital almost without limit is offered for Cuban enterprises and almost without effort the trade of the island turns towards the United States.

In the far Pacific, however, there is a serious problem which successful conquest has thrust upon us. The Philippines, with their ten millions of people, have offered a meager market for American goods. While buying from them about $5,000,000 worth of their products we have been able to sell to them less than a twentieth part of that value. From all accounts the Philippines are as rich in resources as the West Indies but lacking development and deficient in purchasing and consuming capacity. So vast an area, however, and so great a population offer possibilities of which the present conditions afford no indication; and there are those familiar with both sides of this problem who do not hesitate to declare that from a purely commercial standpoint the Philippines are bound to become not far hence of more consequence than the West Indies. Be this as it may, it still seems apparent that there is in the Philippines opportunity for a very large increase of our present commerce.

The great foreign trade movement which received its most powerful impetus three years ago continues with unabated activity. Again the statistics of our exports record the largest volume of foreign business that has ever been transacted. The exports for the year ending June 30, 1898, reached the total of $1,210,292,097, a gain of $178,000,000 over the previous year. The exports of American manufacturers in the last fiscal year amounted to $288,871,449, a total greater by twelve and a half millions than ever previously recorded.

While many factors have contributed to this great extension of our foreign trade, probably no influence has been more noted than the efforts of the manufacturers of the United States. Individually and by united action they have worked persistently in the development of their foreign trade and have pushed their products into many markets where heretofore they have been unknown.

With the exception of a few industries affected by peculiar conditions, the manufacturing interests of the United States, as a rule, are enjoying both activity and a fair degree of prosperity at the present time. Labor of every class is well employed and in many instances reductions in wages during recent years have been revoked and former rates restored. Taking a broad view of the country there are evidences of activity and signs of prosperity on every hand, and the conditions which now present themselves form a contrast as pleasing as it is striking in comparison with the state of affairs two or three years ago.

The work of the National Association of Manufacturers during the past three years has been devoted mainly towards the promotion of the foreign trade of our members and to other matters more or less directly related to this purpose.

It must not be assumed that we have accomplished all that is to be done in the extension of our foreign trade. There are matters of legislation, both State and National, which invite the serious attention of the manufacturers of the United States. We cannot afford to neglect our interests at home while we are extending our business abroad.

It is not the aim of the National Association of Manufacturers to supplant any of the other commercial organizations nor to detract in any manner from their importance. On the contrary, our Association should always be ready to lend its aid to other organizations and in return receive their support in any work that is for the common good.

One matter which has frequently come before the Association in years past will suffice to show the importance of such a policy. The multiplicity of State laws affecting foreign corporations is a constant vexation and injustice to those manufacturers and merchants whose business operations are so scattered throughout the country as to necessitate the maintenance of branch houses in different States. Compliance with all these State laws imposes large expenses upon our business interests and neglect of these legal requirements invites complications of many kinds. The constitutionality of these State laws is seriously questioned and in some cases is proven; but it is manifestly impossible for the National Association of Manufacturers or any other existing organization to undertake, single-handed, the removal of this evil.

Our interests in Washington are of such importance that it is necessary that some provision should be made for the representation of the Association there in such a manner as to insure our recognition whenever desired. It should be the duty of some officer of this Association to keep closely in touch with legislative matters, and should be ready at all times to confer with members of Congress when they need information about the manufacturing interests of the country and the wants of our manufacturers.

One of the cardinal points in the declaration of principles adopted as the foundation for the National Association of Manufacturers was this expression:

"Believing that ships sailing under the flag of the United States should carry our entire maritime commerce, and in view of the injury thereto by subsidized foreign shipping, we declare in favor of a judicious system of subsidies in order to complete restoration and extension of our merchant marine."

A committee representing the interests of shipowners, the shipbuilders and the manufacturers whose products furnish the freight for our maritime commerce has been engaged for a year past in an endeavor to frame legislation calculated to encourage the development of a great merchant fleet. The result of this work is Senate Bill S. 5024, entitled "A bill to promote the commerce and increase the foreign trade of the United States, and to provide auxiliary cruisers, transports and seamen for Government use when necessary."

This measure seeks to encourage the building and operation of ships under the American flag by the payment of subsidies based upon tonnage and distance traveled; this compensation being granted upon the condition that the owners of the subsidized vessels shall construct within a period of five years new American tonnage equal to at least 25% of the tonnage of the vessels receiving such compensation. Provision is made for further increase in our shipping by granting American registry to foreign-built vessels upon the condition that the owners shall construct within a period of five years new American tonnage equal to at least 50% of the tonnage of the foreign-built vessels thus admitted to American registry. Other provisions require that at least one-fourth of the navigating crew of any of the vessels receiving subsidies under this act shall be citizens of the United States, and that all vessels coming under the provisions of this law shall at any time be available for use as cruisers or transports by the United States Government.

Interest in the construction of a Nicaraguan canal has been stimulated powerfully by the incidents of the late war with Spain and by the commercial expansion of the United States which has resulted from the brief conflict. Arguments heretofore advanced in behalf of the various interoceanic canal projects have been more essentially of a commercial character; but while the importance of a canal from a purely mercantile standpoint has in no way diminished, the political and strategic value of a waterway across the central American isthmus has been increased enormously during the past few months. The whole tendency of the Nicaragua Canal agitation of late has been more and more strongly in the direction of the United States, and in fact under the actual ownership of our nation. In the minds of the people this subject is becoming more and more a public enterprise in which private interests are figuring only in the promotion and preliminary work.

It seems highly proper for us as business men to give clear expression for our belief in the co

necessity of a canal across Nicaragua and to our conviction that whether constructed by a private corporation or upon funds supplied by our Government, the canal should be first, last and always an American enterprise and under the control of the United States. With our new possessions in the Far East we need now as never before a way of quick communication by water between our Atlantic and Pacific coasts. In the Orient are the largest undeveloped markets for our products, and our growing trade there demands better and cheaper means of transportation than our transcontinental railway lines afford. The millions which a Nicaraguan canal would cost would be well spent if devoted to such an end by our Federal Government.

While the interest of our manufacturers in the proposed Department of Commerce and Industries has not diminished in any degree during the past year, but little substantial progress can be reported as compared with the situation of one year ago. The bills that have been pending are still before the committees of the House and Senate.

It is believed that in the incoming Congress there will be a larger sentiment favorably disposed towards such action than has existed in the present body. The continual expansion of our foreign trade and the certainty of still greater development in the same direction add constantly to the arguments in behalf of this new Federal Department, and when the proper time comes this Association will be able to exert its influence powerfully in support of the desired legislation.

With the near approach of the great world's exposition which will be held in Paris in 1900, increasing interest attaches to this event.

Under the Sundry Civil Appropriation act of July 1, 1898, the sum of $750,000 was provided for the organization of a commission to attend to American interests and to prepare exhibits for the several Government departments, and the appointment of Mr. Ferdinand W. Peck, of Chicago, as Commissioner General has given vitality to the act of Congress. It is fairly recognized, however, that the $750,000 appropriated for the purpose will be quite insufficient for future requirements and at least $1,000,000 will probably be needed to continue and complete the work already begun.

This is the case in which the United States cannot afford to pursue a narrow or parsimonious policy. The products of our industries will stand side by side with the work of the manufacturers of all nations. We must either make a showing that will substantiate our claims of superiority or else our industries must suffer great injury. Upon no occasion have our manufacturers been put in such a defensive position before the world. The pushing of our trade into every country and the vast expansion of our foreign business have made widely known our ability to compete with the older nations in all the principal branches of industry. The skill of our work-people and the aggressiveness of our manufacturers have been widely heralded; the world will look to the Paris Exposition for a substantiation of these claims, and unless our manufacturers shall show at Paris the best of their handiwork the reputation of our industries will suffer enormously.

The attention of members of this Association has been repeatedly directed towards the great advantages to be derived by our manufacturers from the extension of our Parcels Post System to foreign countries. In this particular agency for conducting international business we are peculiarly at a disadvantage in competition with foreign manufacturers. Our present Parcels Post System is of comparatively small value, and the limited extent to which it is used affords no basis upon which to judge of the volume of foreign trade which could be developed with proper facilities of this character. Our present Parcels Post Conventions, fifteen in number, embrace Central and South American countries and points in the West Indies which are of minor commercial importance, with the exception of Mexico, and in several instances the limitations of the service are such as to lessen its utility to a great degree. We are making but very little progress in the extension of this system. There is no evidence that the postal authorities of the United States are disposed to undertake the extension of the Parcels Post System except at the instigation of the business interests of the country, and the lack of a well-defined and strongly-supported demand is one of the chief causes why the system of foreign parcels post has not been extended to mort important countries.

As compared with the general overhauling of the consular service of the United States during 1897 the changes during the past year have been few in number and importance. Those officials who were newly appointed in 1897 have had the opportunity to adjust themselves to their surroundings, and many of them have proved to be efficient, energetic and watchful of their country's interests. This fact, however, does not in any way diminish the force of the arguments used in behalf of the readjustment of the entire consular service of the United States upon a strictly business basis. The organization of an efficient consular service presents no problem that could not be solved without difficulty by the average business man. For years the business men of the United States have striven to eliminate the element of politics from this branch of the public service, and to impart ordinary business methods and principles to a governmental department that is essentially commercial in character.

Work that is of great importance and practical value to the members of this Association has been undertaken during the past year by the Committee on International Freight and Transportation. The work of this committee has embraced two principal objects:

First. The modification of the clauses affecting the liability of the carrier in bills of lading used by ocean steamship lines.

Second. The organization of a bureau to handle foreign shipments for members of the Association.

Under the direction of the Committee on International Freight and Transportation there has been established in New York a Bureau which is now prepared to attend to all the details of foreign shipments by members of the Association. Under the direction of Mr. William C. Barker, chairman of the committee, who has assumed charge of this Bureau temporarily, contracts have been negotiated with different transportation lines which will enable the members of this Association to make shipments to foreign ports under advantageous conditions. The services contemplated in the organization of this Bureau are quite comprehensive and embrace the forwarding of merchandise from the port of shipment in the United States and attention to all details until the goods are finally delivered at destination.

The organization of this Bureau embraces representation in all the principal foreign ports by responsible agents, who are prepared to care for all shipments entrusted to them and to make deliveries and collections wherever required.

The most important undertaking of the Association in a practical business way has been the sample warehouse in Caracas, Venezuela. The formal opening of this warehouse took place on March 29, 1898, and the inauguration of this enterprise was regarded as one of the most important events in the commercial history of Venezuela.

The recognition given to this enterprise at the start by the Government and by the business interests of Venezuela established its standing before the people of that country, and the warehouse of this Association now occupies a position in the public esteem which it would be well-nigh impossible for any private enterprise to attain.

The exports from the United States to Venezuela in December, 1898, were 60 per cent. greater than in the same month of the preceding year, and the warehoues of the National Association of Manufacturers in Caracas is entitled to credit for a very considerable portion of this increase.

The Caracas warehouse has demanded so much attention during the past year that it has not been deemed advisable to proceed definitely with any other establishment of similar character, but the time is near at hand when the Association will be ready to inaugurate another enterprise of this kind. In the judgment of your President, Hamburg presented and still presents the strongest claims of any European point for consideration in the location of the next warehouse.

In response to the demands of those members of the Association whose interests center largely in foreign trade, there has been a considerable expansion of the work of the Bureau of Information during the past year, and the development has been along eminently practical lines, with very material benefit to those who have availed themselves of the results.

The aim of this Bureau has been to maintain records of the more important business houses in all parts of the world, with detailed information as to the kind of goods they handle and the particular lines of American products in which they are most interested. The number of inquiries received from foreign buyers grew so rapidly that it soon became impossible to place all this information before the members of the Association by correspondence. To accomplish this end in the most satisfactory manner the publication of Confidential Bulletins was undertaken, and is now being continued with excellent results. The inquiries received from foreign merchants are now published at frequent intervals in the form of a confidential circular, which is sent to every member of the Association, and each member then has opportunity of selecting such inquiries as may be of interest.

The publication of "American Trade," the fortnightly paper of the Association, has been continued as usual and has proved a most valuable agency for conveying information to members of the Association and for making the work and purposes of the Association known throughout the world.

Commercial high schools are one of the urgent needs of the times and none have a deeper interest in their establishment than the manufacturers or the business men of the country. It should be the aim of the members of this Association to encourage in every way possible the establishment of local schools of this character. The keenest competitors encountered in foreign markets are those who have had the advantages of thorough technical and commerical education, and there is no reason why our young men should not be permitted to equip themselves for business life in similar manner.

In the afternoon the report of the Treasurer, Mr. Chas. A. Schieren, was considered. This gave the total income as $51 692, the expenditures as $49,055, leaving a balance of $2,637.

Other committee reports were considered, among them one from the Committee on Language, Weights and Measure, which recommended the adoption of the metric system of weights and measures and legislation providing that after July 1, 1900, this system shall be employed by all departments of the government.

The morning of the second day was devoted to a consideration of the President's report, which was read on the previous day. The discussion was continued during the afternoon session, and resolutions were passed thanking the Chamber of Commerce of Caracas and the President of Venezuela for assistance given the National Association. A motion to establish a branch office in New York city was referred to the Executive Committee.

At the third day's session Mr. Ferdinand W. Peck, United States Commissioner-General to the Paris Exposition, delivered an address on the Exposition, and among other things urged that the annual convention of the Association for next year be held at Paris. Assistant Commissioner Woodward also addressed the convention. Boston was finally selected as the place for the next annual meeting, and January as the time.

The following officers were elected for the ensuing year: Pres., Theodore C. Search, Philadelphia; Secy., T. P. Wilson, Cincinnati; Treas., Charles A. Schieren, New Yor; Vice-Presidents—Alabama, A. F. Bend; California, J. G. Hamilton; Connecticut, Pliny Jewell; Delaware, Charles W. Pusey; Georgia, J. F. Hanson; Illinois, C. F. Quincy; Indiana, D. M. Parry; Kentucky, R. F. Balkey; Louisiana, F. M. Young; Maine, Charles R. Mulliken; Maryland, David L. Bartlett; Massachusetts, George T. Coppins; Michigan, O., H. L. Werneke; Mississippi, W. T. Adams; Missouri; L. D. Kingsland; New Hampshire, F. B. Pike; New Jersey, Benjamin Atha; New York, Charles A. Moore; North Carolina, D. M. Tompkins; Ohio, H. C. Yeiser; Oregon, L. D. Cole; Pennsylvania, John H. Converse; Rhode Island, Samuel M. Nicholson; South Carolina, Ellison A. Smythe; Tennessee, C. D. Mitchell; Vermont, Henry Fairbanks; Wisconsin, Frederick W. Sivyer. The Executive Committee—Theodore Search, Philadelphia; Charles A. Schieren, New York; E. P. Wilson, Cincinnati; Charles A. Moore, New York; John H. Converse, Philadelphia; C. F. Quincy, Chicago; H. C. Yeiser, Cincinnati; L. D. Kingsland, St. Louis; Frederick W. Sivyer, Milwaukee; D. M. Parry, Indianapolis; George F. Coppins, Boston; Benjamin Atha, Newark; O. H. L. Werneke, Detroit; Pliny Jewell, Hartford; Richard Young, New York; C. D. Mitchell, Chattanooga; Robert Laidlaw, Cincinnati; and B. F. Jones, Pittsburg.

Among the excursions and entertainments the trip to the factory of the National Cash Register Co., at Dayton, Ohio, proved most enjoyable.

ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.

The fourteenth annual meeting was held at Champaign, Ill., Jan. 25, 26 and 27, the headquarters being at the Beardsley Hotel and the meeting being held in the Engineering Building of the University of Illinois. The attendance was somewhat limited.

At the opening session, on the afternoon of Jan. 25, Prof. A. N. Talbot welcomed the society, in the absence of President Draper, of the University, and the President of the society, Mr. A. D. Thompson, of Peoria, presented the annual address. The report of the Secretary, Mr. Jacob A. Harman, of Peoria, showed receipts of $608 and expenditures of $605, and recommended an increase in revenue to cover a deficit and to enable copies of the papers to be printed before the meeting. The report of the Committee on Public Highways was then presented by the secretary, and there was a general discussion on roads, tile drains for roads, the establishment of section corners, and the use of brick culverts for roads. A committee on road legislation was also appointed.

In the evening Prof. W. D. Pence read a paper on "The Surveying Standards of the University of Illinois." These include (1) a 100-ft. measure between copper bolts set in concrete monuments, (2) a standard elevation above sea level (720 ft.), (3) a meridian marked by copper monuments embedded in concrete, and (4) its triangulation points in the official surveys of the University. This was followed by three papers upon closely related subjects, as follows: "Can Our Public Contracting System Be Improved," by J. H. Burnham, of Bloomington; "Engineering Ethics," by Mr. C. C. Brown; and "The Theory and Practice of Getting Jobs," by J. W. Alvord, of Chicago. Mr. Burnham recommended the licensing of contractors, after their capability and financial standing have been proved, so as to do away with the evils resulting from letting contracts to the lowest (and perhaps least efficient and least responsible) bidder. Mr. Alvord's paper was of a humerous character, but none the less interesting. His rules are: (1) Find your job; (2) know more about how the job ought to be done than anybody else; (3) know the men who have the job to give.

On the morning of Jan. 26 a number of members visited the septic tank of the Champaign sewage disposal system. At the morning meeting the report of the Committee on Municipal Engineering was presented by Mr. J. W. Alvord, which brought out some discussion of the new local improvement law passed by the state legislature last July, and which seems calculated to discourage improvements in cities having less than 25,000 population. Prof. Ira O. Baker then gave a very interesting talk upon "The Economics of Cement Mortar," showing the economy deduced from a comparison of the relative fineness, strength and cost of different cements. All his tests and investigations go to show that for strengths under 370 lbs. per sq. in., after six months, natural cement is more economical than Portland cement.

Mr. D. W. Mead then presented the report of the Committee on Sanitary Legislation, which approved a bill which has been prepared, putting the State Board of Health in charge of all inland water supplies, and requiring them to confer with towns and villages contemplating systems of water supply, sewerage and sewage disposal. The Road Committee, appointed on the previous day, then presented a resolution approving the division of cost of road improvement between the state, county and district (the latter by special assessment), and advocating the employment of state prison convicts upon road work. This resolution was adopted.

Mr. W. H. Tarrant then read a short paper describing the "Concrete Curb and Gutter" now being so extensively used in Western towns, after which Prof. Baker exhibited and described the University's collection of computing instruments and books. These include books of tables of multiplication (which are more rapid than logarithms), adding and multiplying machines, slide rules, the Thacher calculating machine and a variety of planimeters. Prof. Talbot read a short paper on "The Working of the Septic Tank of the Champaign Sewerage System," and the meeting then adjourned.

In the afternoon Mr. Darling, of the Committee on Instruments, Blanks and Records, called attention to the manufacturers' exhibit made for the meeting, and a very brief report of the Committee on Drainage was presented by Mr. W. E. Evans. Prof. A. N. Talbot then read a paper on "A New Form of Sewer Invert Block." The block is of clay, of much shorter radius than the brick sewer of which it is a part, and thus forms a kind of gutter, increasing the velocity of small flows in the sewer.

The revised constitution and by-laws were then read by Porf. Baker, and after some little discussion they were adopted. The next place of meeting was then taken up, and Moline was selected. The meeting then adjourned to enable the members to make a tour of the engineering buildings.

The first business of the evening session was the election of officers, which resulted as follows: President, A. D. Thompson (re-elected); Vice-President, Geo. W. Chandler; Trustees, E. E. Johnson, C. C. Brown and J. W. Alvord.

A report of progress by the Committee on Paving Brick Specifications and Tests was presented by Prof. Talbot, and Mr. W. H. Rosencrans read the report of the Committee on Railways, giving particulars of the mileage of steam railways and the rapid growth of electric interurban railways. Mr. Rosencrans followed this with a paper on "Some Details of Modern Street Railway Construction," describing the methods of track construction in different cities.

An interesting paper on "The Relation of the Constitutional Limitation of the Financial Powers of Municipalities as to Public Works" was then read by Prof. C. W. Tooke, of the Law Department of the University, and this brought out some discussion on methods of assessment for taxes. The last paper of the session was on "Railway Map and Profile Records," by Mr. V. K. Hendricks, of the Terre Haute & Logansport Ry. This described forms of record to show graphically the real estate boundaries, tracks, stations, fences, mile posts, road crossings, and other property and appurtenances, as well as the alinement and profile.

At the morning session of Jan. 27 a considerable amount of business was disposed of, so as to conclude the proceedings, as many members intended to leave by afternoon trains. Mr. A. C. Loomis read a paper on "A Central Heating Plant," describing a plant on the Young system, in which water is heated by exhaust steam and pumped through mains at 30 lbs. pressure, being piped to radiators in the houses. Thermostats, with valves operated by compressed air, control the temperature. The water has a temperature of about 185° in the supply pipe and 80° in the return pipe. A resolution was then presented and adopted in favor of the bill for a State Board of Health as outlined at a former meeting, and Prof. I. O. Baker then gave a summary of the report of the Committee on Sewer Pipe Specifications and Tests. Prof. Breckenridge gave a brief statement of "The Test of the Nordberg Pumping Engine at Aurora, Ill.," and Mr. C. C. Brown presented the report of the Committee on Water-Works, with a table of the cost of pumping at various plants. Another resolution was then adopted in favor of certain amendments to the new Local Improvement Law. Mr. D. W. Mead then read a paper on 'The Commercial Transformation of Energy," showing by diagrams the various losses by different systems.

The President of the University, Dr. Andrew S. Draper, then made a few remarks, referring to the importance of the technical education of those who intend to take up the profession of engineering. He said that the agricultural element is objecting to the sums of money spent on the engineering department of the University, but as the farmers' boys insist on coming to be trained as engineers he did not think the University trustees should be blamed for meeting the evident demands of the people. Dr. T. J. Burrill then read a paper on "Bacteria and Their Activities," and after brief remarks by the newly-elected officers the final adjournment was taken.

ANNUAL MEETING OF THE INDIANA ENGINEERING SOCIETY.

The nineteenth annual meeting of the Society was held at Indianapolis, Ind., Jan. 24, 25 and 26, the headquarters being at the Hotel English and the meeting being held in one of the committee rooms of the State House. The Society has adopted the plan of meeting every year at Indianapolis, instead of at a different place each year.

At the opening session the Secretary, Mr. J. B. Nelson, of Indianapolis, presented his report, showing receipts of $399 and expenditures of $378. A brief report from the Executive Committee was also presented, and after the roll call of officers and chairmen of committees the meeting adjourned, to allow members to renew and extend their acquaintance.

At the afternoon session the annual address was presented by the President, Mr. A. J. Hammond, of Terre Haute, Assistant Engineer of the Vandalia Line. He thought engineers should take more active interest in public affairs, for the improvement of work and administration in state, city, county and township affairs. The general public and such officers as councilmen and commissioners rarely understand the relation of engineering to the health and welfare of the community. The construction and maintenance of country roads should be entrusted to competent engineers, but the cost of maintenance of roads is becoming out of all proportion to the mileage, in consequence of the farming out of road repairs for political rewards, so that while many roads are left in defective condition others are "repaired" whether they need it or not.

The first paper was by Prof. W. K. Hatt, of Purdue University, on "Methods of Testing Paving Brick," in which diagrams were presented showing the lack of relation between the various tests as to absorption, crushing strength, tensile strength and resistance to wear and abrasion as indicated by the rattler test. Samples of various kinds of paving brick were exhibited, which had been subjected to the rattler and cross-breaking tests, and it was noted that a somewhat soft brick with a highly glazed surface had suffered very little from abrasion, the foundry shot used in the rattler having apparently glanced off from this surface.

An interesting paper on "Road Maintenance" was then read by Mr. Daniel B. Luten, Instructer in Civil Engineering at Purdue University, illustrated by views of dirt and gravel roads in various conditions. Mr. Luten took the ground that while stone roads and the reconstruction of roads have been persistently advocated, they should be subordinated to methods of proper maintenance of existing roads. As to the common system of working out the road tax by labor, he compared this to a system by which farmers would work out their school taxes by acting as teachers in their local schools. The contract system of road repairing was also considered entirely unsatisfactory, the object of the contractor being to use as little money as possible on the roads, so as to pocket a larger share of the contract price. The system favored was that of "constant maintenance" by men permanently engaged in road work, as in foreign practice. The author suggested allotting a man and team to 15 or 20 miles of road, as the cost of a number of men on short sections would, at the present time, be too costly to be practicable.

Instances were given of stone roads worn into most disreputable condition through lack of maintenance, and also a case where the commissioners became tired of constantly repairing a gravel road and therefore covered it with 6 ins. of loose broken stone. As might be imagined, the stone immediately began to wear out in ruts as the gravel had done. Mr. Luten showed how existing conditions might be materially improved by filling ruts and keeping them filled, draining the road surface by cross drains, and otherwise preventing the waterlogging and rutting of the surface.

The discussion turned largely towards legislation and the methods of road administration, in which the incompetent county surveyor—who is neither an engineer or surveyor—came in for a share of attention. Mr. E. E. Russell Tratman (Associate Editor of Engineering News) expressed the opinion that the Society ought to make its influence felt in the legislature, especially in regard to the numerous road bills which are to come before the present session. He related his experience with a member of the legislature whom he had met at the hotel, who had never heard of the Society, and when informed of its annual meeting spoke of it as a steam-fitters' association. This line of discussion was followed up, and eventually a resolution was adopted for presentation to the Road Committee of the legislature, setting forth that the Indiana Engineering Society favored the "constant maintenance" system for country roads.

In the evening two papers, profusely illustrated by stereopticon views, were presented. Prof. W. F. M. Goss, of Purdue University, real a paper on "The Training of an Engineer," in which he described the courses and equipment of the University and various examples of engineering structures, including engines, steamships, steel frame buildings, bridges, etc. Prof. R. L. Sackett, of Earlham College, Richmond, Ind., then read a paper on "Modern Engineering," and illustrated a great number and variety of engineering works in this country and abroad.

At the morning session on Jan. 25, Mr. W. V. Rooker, an attorney of Indianapolis, gave a short address in regard to some of the road bills now before the legislature. The outcome of the discussion on this address was a resolution enlarging the powers of the committee appointed on the previous day to present a resolution to the House Committee on Roads, and directing it to confer with the House committee in regard to the road bills. A short paper on "How Should Field Notes be Kept" was then read by Mr. John W. Fawcett, of Delphi, and in the discussion Mr. H. B. Fatout favored a law requiring that there should be made and filed a definite plat and description of every subdivision for permanent record.

Mr. J. J. Billingsley, editor of "The Drainage Journal," then read a paper on "Farm Drainage," which was followed by another on "Drainage," by Mr. J. S. Spiker, of Vincennes. The former paper advised engineers to seek to instruct farmers as to the practical benefits of drainage. The latter paper referred to the influence of drainage upon public health, in reducing the percentage of chills and fever, throat affections, etc. It also referred to the influence upon land values, cases being cited where lands formerly sold at $4 per acre, were now sold at $100 an acre, owing to their improved condition. A resolution was passed to appoint a committee to prepare tables of the discharge of tile drains at various grades.

The first paper of the afternoon session was a humorous one, in dialect, by Mr. John E. Alter, of Rensselaer, entitled "A Botanical Survey," advising the engineer to see the beauties of nature as well as the direction of his lines. Mr. C. G. H. Goss, of Martinsville, Ind., then read a paper on "Public Work and the Civil Engineer," in which he compared the care, system and skill required in private business with the unsystematic, uneconomical and improper way in which much of our public business is conducted. He also referred to the obstacles which the city engineer has to surmount, and which are due to what is commonly termed "politics," though he argued that every man ought to be a politician in the sense of having and acting upon political beliefs and principles.

Mr. F. Herbert Snow, of Boston, Mass., then delivered an interesting address upon "American and European Methods of Sewage Disposal;" and in the evening an illustrated lecture on "The Purification of Water Supplies" was delivered by Mr. John W. Hill, of Cincinnati, O.

At the morning session on Jan. 26, a paper on "Street Paving" was read by Mr. B. J. T. Jeup, City Engineer of Indianapolis, which was followed by one on "City Monuments," by Mr. John V. Coyner, of Indianapolis.

Officers were elected as follows: President, A. J. Hammond, of Terre Haute; Vice-President, J. S. Spiker, of Vincennes; Secretary, J. B. Nelson, of Indianapolis; Executive Committee, J. A. Mitchell, of Noblesville; H. B. Fatout, of Indianapolis, and Prof. R. L. Sackett, of Richmond.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

The fifth annual meeting of this Society was held in New York city, in the rooms of the American Society of Mechanical Engineers, on Jan. 24, 25 and 26. The first session, held on Tuesday afternoon, Jan. 24, was a business session. The retiring President, Mr. Wiltsie F. Wolfe, made an address, and the reports of officers and of committees were presented. Among these reports were a number made by individual members concerning the ventilation of school houses in their own cities. They were presented in writing and could not be conveniently discussed, as they deserved to be, and it was ordered that they be printed and distributed for discussion at the semi-annual meeting.

The report of the Committee on Compulsory State Legislation, in regard to the ventilation of school houses and other public buildings reported that it had not succeeded during the year in getting any of the states to pass the desired bills, but that a bill had last year passed the New York state Senate, but failed to obtain consideration in the Assembly. A long discussion followed the presentation of this report, in which the difficulty of procuring legislation on matters that related to the health of the people but had no politics in them was freely commented on. The Committee on Compulsory Legislation was continued, with instructions to devote special attention to New York state, since it is believed that other states will follow New York if she sets the example.

The second session was held in the evening. The tellers reported the result of the election of officers as follows: President, Henry Adams, Baltimore, Md.; Vice-Presidents, D. M. Quay, A. E. Kenrick and T. A. Williams; Secretary, Wm. M. Mackay; Treasurer, J. A. Goodrich; Managers, J. A. Jellett, W. A. Wolfe, B. H. Carpenter, H. C. Meyer, Jr., and A. A. Cary.

The reading and discussion of professional papers was then taken up. The papers had been printed in pamphlet form for distribution at the meeting. The first paper was entitled "Necessity for Ventilation," by H. Elsert. This paper is practically a compilation of the data given in the introductory chapters of text-books on heating and ventilation, including products of respiration and combustion, gases from industrial processes, generation of heat by living beings and illumination, the required change of air in order to maintain a given standard of purity. Two pages of tables are given, showing results of experiments in generation of carbonic acid and of heat by human beings and by lights. The paper will be valuable for reference when it is bound in the proceedings, but it was not of such a nature as to invite discussion.

The next paper was entitled "Heating a Private Residence with a Warm Air Furnace." This paper, somewhat condensed, with a brief abstract of the discussion, we printed in our issue of Jan. 26. The discussion was very lively and interesting, and kept the session occupied until 10.30 p. m., when it was adjourned to meet on Wednesday afternoon.

At the next session the first paper was by Prof. R. C. Carpenter, of Cornell University, entitled "Investigations of a Blowing Fan." Prof. Carpenter has made many investigations of fans during the past three years. The particular fan described in the paper was one made especially for experimental purposes, and made adjustable, so that the form of both the casing and the blades could be changed. The principal conclusions reached from the experiments we condense as follows:

The first investigation established the following propositions which were advanced some years ago by Murgue.

First, the volume of air delivered varies with the speed of rotation.

Second, difference of pressure varies as the square of the speed.

Third, the power required varies with the cube of the speed.

The object of the later investigation was to determine the most efficient form of fan blade, and also the effect due to variation in size of outlet and inlet. For the purpose of testing fans with different shaped blades the radial blades were removed and bent blades substituted which were radial for a distance of 7 ins., then curved in an easy bend in a direction approximating tangential at the

outer extremities. The bent blades were arranged so that they could be operated with the curved end run in a backward or forward direction. The area of the plane blades in the direction of the radius was 1.5 sq. ft., the projected area of the curved blades on a radial plane was 1.37 sq. ft. As compared with the radial blades there was a loss in quantity of air delivered for a given rotative speed of nearly 25% when the blades were bent backward, and but little loss when the blades were bent forward. As normally constructed there was but one inlet to the fan, which was 22 ins. in diameter. For a portion of the experiments a second inlet of the same size was constructed on the opposite side, so that experiments were made with the radial blades with two inlets.

Relation between horse power delivered to fan and outlet area: The blades bent backward take the smallest amount of power for a given outlet; the radial blades an intermediate amount, and the blades bent forward the greatest amount. The power required for the radial type of blades for very small openings was decreased, but for larger openings was increased by doubling the inlet opening, which effect is accounted for by noting that the quantity of air delivered is greatly increased for the larger openings.

Relation between the quantity of air delivered in cubic feet per second and the area of outlet opening for a constant speed of 500 revolutions per minute: With a single inlet opening the greatest quantity of air for a given outlet area was obtained with the fan which had the blades bent forward, the amount delivered by the radial blade being intermediate, that by the blades bent backward the least. The effect of doubling the inlet area was to increase the quantity of air delivered by the radial fan very materially for the larger openings.

Variation in the quantity of air delivered per horse power in cubic feet per second due to changing area of the outlet, and consequently the back pressure: The best results were obtained from the fan with blades bent backward. Rounding off of the tips of the blades and bending them backward decreases the amount of air delivered, and also the power required to drive the fan, as compared with the other conditions, but the power required to drive the fan is reduced more than the delivery of air, consequently the air delivered per horse power is the greatest, or, in other words, the efficiency of this type of fan is the greatest of the types compared under the same condition of inlet. Doubling the area of the inlet, for the fan with radial blades for a small area of outlet or for back pressures much exceeding one inch of water, made no special change in the results, but for large area openings or when the pressure is less than about one inch of water much more air is delivered.

Relation between the velocity of delivery, the back pressure and the area of outlet: For the two conditions of the radial blades and blades bent forward, the velocity of the discharge exceeds the peripheral velocity of the fan when the back pressure corresponds to about 1.6 ins. for the case considered. For a higher or a lower back pressure the velocity becomes less.

The type of blade which gives the lowest velocity of air gives the best result as to the quantity of air per horse power, from which it would appear that the most effective fan is the one which delivers the air at the lowest velocity. With the type of blade bent backward at the tips, the maximum velocity lacks 11 ft. per second of reaching the peripheral velocity of the fan; the other three types exceed the fan velocity at the maximum point as already mentioned. It is probable that the reason why the blades bent backward do not give so high a velocity is due to the slipping of the air over the tips of the blades.

Relation between efficiency of the fan, the area of outlet in square feet and the pressure produced by the radial type of fan: Each type of fan has a condition of maximum efficiency with constant speed which occurs under the condition of the test with the fan with blades bent forward when the back pressure is about 1.7 ins. of water, for the fan with the radial blades when the pressure is about 1.5 ins., and for the fan with blades backward when the pressure is about 1.4 ins. The fan with the blades bent backward has a maximum efficiency of about 43.5%; the fan with the blades bent forward has a maximum efficiency of 37%, and with the radial blades a maximum efficiency of about 33.6%. The fan with the radial blades double inlet had a maximum efficiency of about 45%, which occurs, however, with a low pressure of air.

Relation between pressure in delivery box and the area of outlet, when the fan is working at a constant speed: The fan with blades bent forward gives the highest pressure, and the fan with blades bent backward gives lowest pressure, but for openings of the delivery tube much in excess of area of the blade, the fan with the double inlet shows the greatest pressures. In all cases that the pressure is greatest when the delivery of air is least. Buckle* gave as results of his experiments the following formula for expressing the relation between the pressure produced and the peripheral speed, a sreduced by Kent in his "Pocket Book for Mechanical Engineers:"

$$v = 60\sqrt{p}$$

in which p is the pressure expressed in inches of water and v is the peripheral velocity of the fan in feet per second. The pressure deduced by Buckle's formula would be obtained under conditions like those in the experiment cited when the area of discharge opening expressed in percentage of the area of the blade was 15% when the blades were bent backward, 18% when the blades were radial, and 25% when the blades were bent forward.

*Paper before Institute of Mechanical Engineers, England, 1847.

I have found by a comparison of Buckle's formula as above with actual tests that the maximum pressure which is produced by a given preipheral velocity is greater than that stated by Buckle by an amount which varies in different conditions from 1 to 15%. The maximum pressure which may be produced is the only one which can be considered as positively depending upon the peripheral velocity, since the actual pressure in any given case depends very largely upon the resistances to a free discharge corresponding in the case of the experiments cited to the area of outlet. The more freely the air is discharged, or in other words the less resistance the less the pressure that will be produced by the fans. Buckle's formula, however, is usually a safe one to employ, since the pressure given by it is less than can be realized in practice, provided the resistance to the flow of air is at a maximum.

Prof. Carpenter's paper was presented in printed form, subject to revision, but the plates of diagrams which are to accompany it were not ready. When finally printed, with additions which are promised, it will be a valuable contribution to the literature of centrifugal fans. Its chief value, perhaps, is in its calling attention to the fact that there is still a great deal to be learned about fans, and that there is a wide margin for improvement in their construction, as shown by the great difference which exists between the efficiencies obtained in experiments and those that are theoretically possible.

The next paper was entitled "Some Points Regarding the Ventilation and Heating of Tall Buildings," by Henry C. Meyer, Jr. We printed a portion of this paper in last week's issue. The discussion which followed the reading of the paper referred chiefly to some matters of detail mentioned in it, such as the use of grease separators, arrangements of piping, back-pressure valves, etc. Some difference of opinion was exhibited regarding the author's statement that unless a filter for separating grease from the exhaust drips was used such drips should be thrown away.

The "Relation Between Architect and Heating Engineer," by Mr. J. N. Thomson, was the next paper. It dealt chiefly with the unsatisfactory design and construction of heating and ventilating apparatus, including the piping systems, consequent upon the engineer not being called in early enough in the preparation of the general designs for a building. The chief fault is that of the owner, who desires to have work begun on the building before the architect has had time to complete the plans, and the result is that the heating and ventilating system is largely the product of "afterthought" rather than of "forethought." The paper concludes as follows:

> I wish that all the architects in the United States could have an opportunity to read this paper so that they might be reminded of the fact that a world of difference exists between the "forethought" job and the "afterthought" job. * * * In a building which, unhappily, is provided with an afterthought system of heating, a peculiar feeling of unrest seems to prevail throughout. Everything seems to indicate to the man of structural ideas that great scrimmages must have existed between the contractors for place, and that the architect has been a secondary man on the building. To the uninitiated, of course, the chaos is unexplainable. They say the building is fine but for the pipes, etc., which are so numerous and prominent that they cannot see anything else, and are located in such a way that there is no place for furnishings. To those of refined feelings and sensitive temperaments the beauty and grace of the buildings are lost in the medley of steam pipes and promontories of modern engineering contrivances.
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> Do the owners of buildings want all this "jumbleation" of monstrosities? No. Do the architects want it? No. Do the engineers or contractors want it? No. Then why should it exist? This question, gentlemen, I leave open for you to decide.

The discussion that followed this paper was able and vigorous. It departed entirely from the ground covered in the paper, which related entirely to the matter of unsatisfactory design, as indicated in the above extract, and took in the whole subject of the general relations existing between the owner, the architect and the different kinds of engineers and contractors who have to do with the design and construction of large buildings. It was shown that the design of a modern office building is more the work of the engineer than of the architect, but that the architect, desiring the customary percentage on the whole cost, too often, instead of calling in the engineer and paying the proper fee for his services, obtains his engineering information gratis from contractors, who are ready to give their time in making drawings, etc., hoping thereby to increase their chances of getting contracts. The subject opened up by the discussion was so large and important that a motion was passed to have Mr. Thomson's paper and the discussion printed in pamphlet form and brought to the attention of the architects, and made a subject for discussion at the summer meeting of the society.

On Wednesday evening a dinner was given at the St. Denis Hotel by the New York members of the society to the non-resident members. About 60 members were present. Mr. Albert A. Wray, member of the New York state Senate, was one of the guests, and he gave a very interesting account of the progress of the bill advocated by the society making compulsory the proper valuation of public schools and other public buildings in the state. The bill passed the Senate without any serious opposition at two successive sessions, but was buried in committee room in the House. He expressed the opinion that the bill will eventually pass, but that some work at Albany by a delegation of the society will be necessary in order to educate the members of the House up to the knowledge that fresh air ought to be provided in a school room.

At the morning session on Tuesday the first paper presented was entitled "Some Tests of Centrifugal Fans," by Wm. S. Munroe, of Chicago. This paper described some interesting tests in connection with the fans which ventilate the Chicago Public Library. These fans are driven by electric motors, and it was found that the supply of air from them was inadequate. On investigation it was found that the fans were run at too low speed. Belt transmission through a counter-shaft was substituted for the double reduction gearing in use, and the current consumption of the motors was increased, with satisfactory results. In connection with the work some investigation was made of the relation between the speed of the air, its pressure and the power required. It was found that under the existing conditions more power was absorbed in sucking the air through the inlet passages and the heating stacks and by-passes than in forcing it through the delivery pipes. It was also found that closing the by-pass around the heater largely reduced the air delivery, and also reduced the power consumed by the fan, which would, in fact, be expected from theoretical considerations.

The next paper was by Prof. J. H. Kinealy, of St. Louis, entitled "Some Formulas of Disk Fans." This paper was published in full in our issue of last week. The discussion on these two papers was brief and unimportant. The rest of the session was taken up in discussion of several of the "topics for discussion," which were printed in the programme as follows:

1. The expense of securing good ventilation in cold climates, and the necessity of careful planning on the part of the heating and ventilating engineer to accomplish the required results and minimize operating costs.
2. The number of air changes per hour which should be allowed for in the different types of buildings.
3. Discharging water of condensation and blow-offs into drainage and sewerage systems.
4. The duty of a heating and ventilating engineer to his client.
5. What are the relative advantages of the upward and downward systems of ventilation for audience halls.
6. Would it not be in the interest of the purchaser to rate the radiators by their heating value based on certain standard conditions?
7. Are the capacities of steam traps as given in makers' catalogues of any practical value to the engineer?
8. Simple methods of breaking up drafts in forced ventilation work.
9. What rules are usually followed for proportioning direct-indirect radiation, and how many heat units are given off per square foot of heating surface per hour under ordinary conditions with this system?
10. General principles to be observed in the installation of blower system of heating and ventilation.
11. What is the practical experience as to the loss of heat from hot-air flues, especially when such must be located in outer walls?
12. Simple, inexpensive schemes for warming and ventilating small buildings (dwellings, etc.).
13. Simple methods of breaking up drafts in forced ventilation work.
14. Does the main body of water in a hot-water heating system circulate, or is heat conveyed through the water as a transmitting medium?

The discussion of some of these topics was highly interesting, and showed that it is often more difficult to answer than to ask a question concerning heating and ventilation, on account of the lack of sufficient experimental data upon which to form an opinion. In regard to the sixth question it was pointed out that the rating of radiators by the square feet of surface was all wrong, that a stack 2 ft. high gave out almost as much heat as a stack 3 ft. high, and that crowding the pipes greatly decreased their effectiveness. The fourth question brought out a statement concerning the actions of some heating and ventilating engineers which indicated that they needed some instructions in common ethics, and that they should be called contractors' agents or salesmen rather than consulting engineers. If the remarks of President Wolfe on this subject are printed in the Society's proceedings they will make interesting, although unpleasant, reading.

At the concluding session on Thursday afternoon the only paper presented was one by Prof. R. C. Carpenter, on "Literature Relating to Blowing Fans." It was practically a bibliography of the subject and was not a paper on which there could be any discussion. The "topics for discussion" were continued till the adjournment.

The meeting was one of the most successful the society has ever had, and the increase of membership, the improvement in finances, and the lively interest shown in the papers, are all evidence that the society is one that is needed by the engineering profession and by the community. The society is strictly a professional one, and nothing of a trade or commercial nature is brought into its proceedings. The next meeting will be held early in the summer, probably at Niagara Falls.